CLINICAL AND RADIOGRAPHIC EVALUATION OF INDIRECT SINUS LIFT WITH SIMULTANEOUS IMPLANT PLACEMENT – 6 MONTHS STUDY

Dissertation submitted to

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BRANCH II

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CERTIFICATE

This is to certify that this dissertation titled **"Clinical and Radiographic Evaluation of Indirect Sinus lift with Simultaneous Implant Placement-6 Months Study"** is a bonafide record of work done by **Dr.Jasmine C** under my guidance during the study period of 2010-2013.

This dissertation is submitted to **THE TAMIL NADU Dr. MGR MEDICAL UNIVERSITY** in partial fulfilment for the degree of **MASTER OF DENTAL SURGERY, BRANCH II- PERIODONTOLOGY**. It has not been submitted (partial or full) for the award of any other degree or diploma.

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LIST OF ABBREVIATIONS

1.	BPPV	-	Benign paroxysmal positional vertigo
2.	CCE	-	Crestal Core Elevation
3.	CEJ	-	Cemento Enamel Junction
4.	CRA	-	Cutting torque resistance analysis
5.	DMC	-	Dental mobility checker
6.	FDBA	-	Freeze dried Bone Allograft
7.	HA	-	Hydroxyapatite
8.	ISQ	-	Implant stability Quotient
9.	KHz	-	KiloHertz
10.	LM	-	Light Microscope
11.	LMSF	-	Localized management sinus floor
12.	MBL	-	Marginal Bone loss
13.	Ncm	-	Newton centimetre
14.	OPG	-	Orthopantomogram
15.	OSFE	-	Osteotome sinus floor Elevation
16.	POWF	-	Pulsed oscillation waveform
17.	PTV	-	Periotest Value
18.	RBH	-	Residual Bone Height
19.	RFA	-	Resonance Frequency Analysis
20.	RGD	-	Arginine Guanine Aspartic acid
21.	RTT	-	Reverse torque test

22. RTV	-	Reverse torque Value
23. RVG	-	Radiovisiography
24. SA	-	Subantral
25. SLA	-	Sand Blasted Acid Etchent
26. TEM	-	Transmission Electron Microscopy

ABSTRACT

BACKGROUND:

Sinus augmentation technique has been reported to be associated with a predictable implant survival in posterior atrophic maxilla. However there is insufficient literature in regards to implant survival without the use of bone replacement graft. The purpose of the present study is to evaluate the clinical & radiological outcomes and post-operative morbidity of indirect sinus floor elevation procedures with simultaneous implant placement without the use of Bone replacement graft.

MATERIALS & METHODS:

Ten systemically healthy patients (5 males and 3 females) within the age group of 25-55 years requiring maxillary sinus augmentation for implant placement were selected for the study. Pre-operative diagnostic evaluation was done using OPG and RVG and residual bone height was measured. Sinus lift procedure under local anesthesia was done by a transcrestal approach using osteotomes and simultaneous implant placement was done without bone graft. Survival of implant and postoperative morbidity were recorded. The parameters assessed were length of implant protruded into sinus and Crestal bone height were observed at base line, 3^{rd} month and 6^{th} month using OPG and RVG and the results were analyzed. Statistical analysis was done using "*One way Anova , Post Hoc test and Paired t test".*

RESULTS:

Clinically, no complications were observed during or after the surgical procedure. There was no significant change in the length of implant protruded into the sinus over a period of 6 months, demonstrated that there was no change in sinus floor level ($P>0.05$).Mesial crestal bone height in group I which is the measurement from implant collar to first crestal contact, showed 2.10±1.10mm at baseline,3.38±0.74mm at 3 months and 4.00±0.63mm at 6 months which was statistically significant ($P<0.001$).Two early implant failures were reported and Seven implants out of ten were successfully restored in function.

CONCLUSION:

Within the limits of this study, it can be concluded that indirect sinus lift with simultaneous implant placement without bone graft can be successfully used for augmentation of maxillary sinus in posterior atrophic maxilla . However, further controlled clinical trials are needed to evaluate the effectiveness and safety of this technique compared to other sinus floor elevation procedures.

KEYWORDS

Maxillary sinus lift, bone graft, simultaneous implant placement.

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INTRODUCTION

Endosseous implants have become a predictable treatment option of replacing fully and partially edentulous sites after the introduction of osseointegration concept in dentistry. Primary implant stability has been reported to be one of the main factors influencing implant survival rates. Several factors, such as implant geometry, preparation technique, and quality and quantity of local bone have their impact on primary stability (**IlserTurkyilmaz 2008)**[46]**.**

The macro design characteristics of an implant such as length and diameter has an important bearing on the bone response. In a systematic review by **Renouard Frank et al (2006)**[80] demonstrated a trend for increase in failure rate with short implants and wide diameter implants which is associated with poor bone quality.

Bone quality and Quantity are critical determinants of clinical success of implant both of which are compromised with posterior maxilla (**Misch JOMI 1987)**[69]**.** Posterior maxillary segment often presents with type III or type IV bone quality (**Lekholm and Zarb's classification 1985)**[58] which may lead to weakened primary stability of dental implants. In addition to this, bone quantity is affected by degree of resorption of alveolar ridge and maxillary sinus pneumatisation which further limits the placement of implant in posterior edentulous maxilla.

It has been reported that implant dimensions of 10mm length and 4mm diameter is a prerequisite for long term survival of implant placement in a compromised situation seen in posterior atrophic maxilla. Hence Maxillary sinus elevation techniques were introduced to augment and or to improve bone quality.

Summers (1994)[99] introduced osteotome sinus floor elevation, which is a minimally invasive technique that allows for localized maxillary sinus elevation, in a alveolar crest with a residual height between 5 and 10 mm using osteotomes and associated with a lesser degree of postoperative morbidity.

A plethora of researchers have evaluated different bone grafting materials inserted in the maxillary sinus cavity. However, studies have shown that the simple elevation of the schneiderian membrane alone can induce bone formation at the maxillary sinus. This technique was based on the concept that the lifting of the sinus membrane and the establishment of a compartment with a blood clot could result in new bone around the inserted implants in a similar way that bone-graft materials maintain the augmented space and promote osteogenesis **(Lundgren 2008)**[61]**.**

Sinus grafting and implant placement can be accomplished as either a one-stage (simultaneous) or two-stage (delayed) procedure. This decision is often dictated by the amount of residual crestal bone height **(Del Fabbro M 2004)**[25]**.** Crestal bone measuring less than 5mm in height is

usually considered insufficient to provide adequate mechanical stability for simultaneous placement of an endosseous implant. If less than 5 mm is present, it is generally preferred to delay implant placement by several months after the grafting phase, with this time dependent on the type of graft material, to allow for adequate graft maturation **(Peleg M 1998, Winter AA 2002)[76,117].**

Although Systematic reviews substantiated the use of the transcrestal approach, (**Tan WC et al 2005)[103]** there is insufficient literature in regards to survival of implants without the use of bone graft.

Hence the present study was undertaken to clinically and radiographically evaluate the survival of implant placed simultaneous along with indirect sinus lift procedure without the use of bonegraft.

AIMS AND OBJECTIVES

The aim of the present study is to clinically & Radiographically evaluate

- The survival of implant placed simultaneously along with indirect sinus lift procedure using osteotome.
- The postoperative morbidity associated with the surgical procedure.

REVIEW OF LITERATURE

IMPLANT SURVIVAL

Implant dentistry has rapidly gained acceptance among practitioners. The success rates and benefits of dental implant therapy are documented in literature.

Implant survival, is the presence of the implant at time of follow-up examinations.Long-term studies have reported excellent implant survival rates when applied for single-tooth replacements (**Romeo et al. 2002)[84].**

Astrand P et al (2004)[5] compared primarily in terms of survival rates and changes in marginal bone levelin two implant systems implants shown that the survival rate for both groups was 97.3%.

Heberer S (2011)[40] concluded that neither the gender, the kind of superstructure, the location of the implant, the tooth status of the opposing jaw or the immediate prosthetic superstructure had an influence on the survival of the implants.

FACTORS INFLUENCING IMPLANT SURVIVAL

Bone quantity and quality in implant placement:

The health status and quality and quantity of bone must be assessed in future implant sites using clinical and radiographic parameters. The most popular current method of bone quality assessment is that developed by

Lekholm and Zarb (1985)[58], shown that Posterior maxillary segment often presents with type III or type IV bone quality which may lead to weakened primary stability of dental implants. In addition to this, bone quantity is affected by degree of resorption of alveolar ridge and maxillary sinus pneumatisation which further limits the placement of implant in posterior edentulous maxilla.

The grading refers to individual experience, and furthermore, it provides only a rough mean value of the entire jaw. Therefore, their classification has recently been questioned due to poor objectivity and reproducibility. **Johansson and Strid (1994)[51]** described a technique whereby bone quality as a function of density and hardness could be derived from the torque forces needed during implant insertion.

Implant related factors

Implant dimensions:

Winkler et al (2000)[116] studied the influence of implant diameter and length on implant success rate. Their results on 3-year survival and stability of various implant lengths and diameters were 90.7% for 3-3.9 mm and 94.6% for 4-4.9 mm implants. Also, longer implants had significantly better survival rates as compared with shorter implants.

Tada et al 2003[102] has shown in type 3 and type 4 cancellous bones, the threads of the screw type implants effectively reduced the degree of stress,

generating moderate strain in bone around thread crests and evenly distributed low strain in other regions. They concluded that increasing implant width is more beneficial for type 1 and type 2 bones and increasing implant length is more beneficial for type 3 and type 4 bones.

Baggi et al (2008)[6] stated that increasing the implant length and width increases the surface area but it has been found that implant width is more important for crestal bone preservation than the implant length as stress values and concentration areas decreased for cortical bone when implant diameter is increased.

Thread geometry

Increasing the functional surface area of an implant will better distribute the stresses, resulting in lesser forces at the crest. Use of threaded implants than the cylindrical implants for crestal bone preservation has been documented in the literature.

Thread depth, thread face angle and thread pitch are some of the varying geometric patterns that determine the functional thread surface and affect the biomechanical load distribution of the implant. The influence of threads can be easily understood as the greater the number of threads present as well as greater the depth of the threads, the more is the functional surface area available.

Misch CE et al (1999)[68] It has been found that the shear force on a V-shaped thread face that is 30◦ which is approximately 10 times greater than the shear force on square thread. Therefore, square-shaped threaded implants will concentrate lesser forces at crestal bone as well.

Implant surface Characteristics

Various techniques of surface treatments have been studied and applied to improved biological surface properties, which favours the mechanism of osseointegration.

Schliephake H (2005)[89] have reported that Titanium surfaces modified with peptides and/or protein domains with RGD seem to facilitate the mechanisms of adhesion and cell signalling via signal transduction, which have shown positive effects on the differentiation of osteoblast.

Stavropoulos A et al (2007)[96] compared implants with a rough surface in their whole length with implants having a 2 mm coronal machined portion when used in association with a osteotome sinus-lift procedure and found that he cumulative survival rate was 82.9%. Implant type, residual alveolar crest height, time of osseointegration, time of implant loading and smoking did not seem to influence implant survival.

Wennerberg et al (2009)[115] in a systematic reviewshown that Implant surface modifications aims at promoting the mechanism of osseointegration with faster and stronger bone formation, to confer better stability during the healing process, thus allowing more rapid loading of the implant.

Implant morphology influences bone metabolism: rougher surfaces stimulates differentiation, growth and attachment of bone cells, and increases mineralization; The main methods that are reported in the literature to create implant roughness are acid etching, sandblasting, titanium plasma spraying and hydroxyapatite (HA) coating.

A current tendency is the manufacturing of implants with micro and submicro (nano) topography. Furthermore, the biofunctionalization of implants surfaces, by adding different substances to improve its biological characteristics, has also been recently investigated.

Surgical Related Factors

Lambert et al (1997)[55] demonstrated that implants placed by inexperienced surgeons were failed twice as likely than those placed by experienced surgeon.

Elias CN, et al (2012)[29] assessed in a animal study the Influence of implant shape, surface morphology, surgical technique and bone quality on the

primary stability of dental implants.. Finally, the study concluded that the primary stability of dental implants is highly dependent on implant design, surgical technique and substrate type.

IMPLANT STABILITY

Branemark *et al* (1969)[10] demonstrated that direct contact between bone and titanium implant surface was possible, defining osseointegration as "the direct, structural, and functional contact between living bone and the surface of a functionally loaded implant". Implant stability is a requisite characteristic of osseointegration (**Zarb 1991)[119].**

Osseointegration is also a measure of implant stability which can occur at two different stages: Primary and secondary. Primary stability mostly comes from mechanical engagement with cortical bone whereas secondary stability offers biological stability through bone regeneration and remodelling **(Sennerby1998)[91].**

Primary stability leads to predictable secondary stability which has shown to increase at 4 weeks after implant placement **(Raghavendra S, Wood MC 2005)[78].** During this period, the lowest implant stability is expected. As a result of osseointegration, initial mechanical stability is supplemented and/or replaced by biological stability and the final stability level for an implant is the sum of the two.Primary implant stability plays a fundamental role in successful osseointegration.

Friberg *et al* (1991)[35] reported an implant failure rate of 32% for those implants that showed inadequate initial stability.

Methods to Measure Implant Stability

Historically the gold standard method used to determine the status of implant stability was microscopic and histological analysis. However, due to the invasiveness of this method and related ethical issues, various other methods have been proposed.

These include

- The surgeon's perception
- Radiographical analysis
- Cutting torque resistance (for primary stability)
- Reverse torque
- Modal analysis
- Implatest
- Insertion torque
- Periotest
- Resonance frequency analysis

The surgeon's perception

This is often based on the cutting resistance and seating torque of the implant during insertion. A perception of "good" stability may be heightened by the sensation of an abrupt stop when the implant is seated.

Radiographical analysis

Radiographical evaluation is a non-invasive method that can be performed at any stage of healing. It has been reported that 1.5 mm of radiographicalcrestal bone loss can be expected in the first year of loading in a stable implant, with 0.1 mm of subsequent annual bone loss.[1,93]

Miguel Penarrocha (2004)[66] evaluated the periimplant bone loss using conventional periapical, Digital periapical and extraoral Panaromic radiographs at the time of prosthetic loading and after 1 year. Average perimplant bone loss was 1.36 mm as measured on OPG, 0.76 on conventional radiographs and 0.95 mm as measured on digital periapical radiographs.

Young-Kyu Shin et al (2006)[118] assessed radiographically marginal bone level around implant with different neck surface. The group with rough surfaced microthreaded implant neck showed least amount of bone loss (mean 0.18±0.16 mm) and the group with machined neck showed greatest amount of bone loss (mean 1.32±0.27 mm) after 1 year of functional loading.

Cutting torque resistance analysis

It was originally developed by **Johansson and Strid**[48] and later improved by **Friberg*et al (1995)***[36] Cutting torque resistance analysis (CRA) can be used to identify any area of low-density bone (or poor-quality bone) and to quantify bone hardness during the low-speed threading of implant osteotomy sites.

Reverse torque test

The reverse torque test (RTT), proposed by **Roberts *et al* (1984)**[81] and developed **by Johansson** (**1987)**[48] and **Albrektsson**[49]**,** measures the "critical" torque threshold where bone-implant contact (BIC) was destroyed. Reverse torque value (RTV) was reported to range from 45 to 48 Ncm.

However, this method has been criticized as being destructive. **Branemark *et al*** cautioned about the risk of irreversible plastic deformation within peri-implant bone and of implant failure if unnecessary load was applied to an implant that was still undergoing osseointegration.

Modal analysis

Modal analysis also termed as vibration analysis, measures the natural frequency or displacement signal of a system in resonance, which is initiated by external steady-state waves or a transient impulse force. It can be performed in two models: Theoretical and Experimental (**Lee SY 2000**)[57]**.**

Experimental modal analysis tests

Percussion test: A percussion test is one of the simplest methods that can be used to estimate the level of osseointegration.[63] The clinical judgement on osseointegration is based on the sound heard upon percussion with a metallic instrument.

Impact hammer method: Impact hammer method is another example of transient impact as a source of excitement force during experimental modal analysis[72] Periotest and Dental mobility checker are currently available mobility testers designed according to the impact hammer method.

Dental mobility checker (DMC) was originally developed by **Aoki and Hirakawa (1986)[4].** It has an electromagnetically driven and electronically controlled tapping head that hammers an object at a rate of 4 times per second.

Periotest has been developed to measure the degree of the periodontal integration of teeth and the stiffness of the bone/implant interface[43.] Periotest uses an electromagnetically driven and electronically controlled tapping metallic rod in a handpiece. Response to a striking or "barking" is measured by a small accelerometer incorporated into the head.The signals are then converted to a unique value called the Periotest value (PTV), which depends on the damping characteristics of tissues surrounding teeth or implants.[90]

Pulsed oscillation waveform

Kaneko *et al* (1991)[53] described the use of a pulsed oscillation waveform (POWF) to analyze the mechanical vibrational characteristics of the implant-bone interface using forced excitation of a steady-state wave.

Resonance frequency analysis

Meredith *et al* (1998)[64] developed an electronic method for testing implant stability called resonance frequency analysis (RFA). It is a non-invasive diagnostic method that measures implant stability and bone density at various time points using vibration and a principle of structural analysis. In vitro and in vivo studies have suggested that this resonance peak may be used to assess implant stability in a quantitative manner **(Lawrence JD 2002)[56].**

According to the pertinent literature several factors, such as implant geometry, preparation technique, and quality and quantity of local bone influence primary stability, and primary stability is one of the main factors influencing implant survival rates.

In a systematic review done by **Esposito et al** (**2010)[32]** evaluated the need of maxillary sinus augmentation techniques when there is a compromised bone quality and quantity in posterior edentulous maxilla. The author concluded that if the residual alveolar bone height is 3 to 6 mm, a crestal approach to lifting the sinus lining and placing 8 mm implants may lead to less

complications than a lateral window approach and placing implants at least 10 mm long.

SURGICAL ANATOMY OF MAXILLARY SINUS

The maxillary sinus (Antrum of Highmore) is one of the most important anatomic structures to be considered during dental implant placement in the maxilla. The maxillary sinus is a quadrangular pyramid-shaped cavity which has an internal lingual base **(Chanavaz M 1990),**[16] lies along the floor of the nose, extends to the zygomatic arch and is lined by the schneiderian membrane. The average dimensions of the sinus are 2.50 cm in width, 3.75 cm in height and 3.00 cm in anterio-posterior depth **(Anon JB 1996)**[3]**.**

The medial wall derives its arterial supply from nasal mucosal vasculature. The frontal, lateral and inferior walls derive their arterial supply from the osseous vasculature (infraorbital, facial and palatine arteries) (**Moss-Salentija 1985)**[70]**.** Pertinently, **Elian et al (2005)**[28] recently reported that 20% of the time intraosseous arteries are < 16 mm from crest of the ridge and may present a complication during lateral window preparation.

The schneiderian membrane cannot be detached from the underlying periosteum. This membrane is thin and fragile and is covered by pseudostratified, ciliated pavement epithelium that allows passage of fluids toward the nasal meatus **(Davarpanah 2001)**[22]**.** The nasal tracheal ostium of

the maxillary sinus, which is located 2.50 to 3.50 cm superior to the antral floor, communicates with the middle meatus of nasal cavity.

A variable number of septa referred to as Underwood's septa divide the floor of the maxillary sinus into several recesses. The incidence of Underwood's septa has been reported at 31.7% with a mean height of 7.9 mm **(Ulm C 1995)[111].**

MAXILLARY SINUS AUGMENTATION CLASSIFICATION

Several Authors have classified Maxillary sinus augmentation technique. At the Consensus Conference on Maxillary Sinus Elevation in **(Jensen OT 1996)[47]**, the members made the following recommendations which depend on the residual bone height (RBH):

- Category A (RBH ≥ 10 mm): classic implant procedure.
- Category B (RBH ≥ 7-9 mm): osteotome technique with simultaneous placement of implants.
- Category C (RBH ≥ 4-6mm): maxillary sinus elevation with lateral access and bone graft and immediate or deferred placement of implants.
- Category D(RBH ≥ 1-3mm): maxillary sinus elevation with lateral access and bone graft and deferred placement of implants.

According to subantral Classification by **Misch 1999,[68]** if there is 12 mm or more of residual ridge remaining, it is classified as an SA-1 site.

SA-1 sites allow for placement of a 12-mm implant without manipulation of the sinus membrane.

The SA-2 Misch classification allows for osteotomes elevating the membrane when 1 mm to 2 mm of sinus lift is needed. Simultaneous lifting of the membrane and implant placement is done in an SA-2 site. An SA-2 site has 10 mm to 12 mm of vertical residual bone at the crest.

An SA-3 Misch classification is when there is at least 5 mm of residual ridge height. With the SA-3 protocol, implant placement can occur at the time of grafting or be delayed 4 to 6 months. This will depend on the quality and quantity of the ridge, and how much initial fixation of the implant occurs.

The Misch SA-4 classification occurs when there is less than 5 mm of bone between the crest of the ridge and the maxillary sinus. A time period of 6 to 10 months of healing should occur before implant placement. The amount of healing time will be dependent on the amount of autogenous bone in the graft and the healing capacity of the patient.

In a SA-3 or SA-4 sinus lift, the elevation of the membrane should be done carefully to minimize tearing of the sinus membrane.

This study follows the Maxillary sinus augmentation classification given by **Hom-Lay Wang & Katranji (2008)[41].**

ABC SINUS AUGMENTATION CLASSIFICATION

Hom-Lay Wang & Katranji (2008)

Class	Location of Sinus floor from the crest of bone (mm)	Width (mm)	Distance from bone crest to adjacent CEJ (mm)	Recommended Procedure
Class A (Abundant bone)	10	5 or greater	3 or less	Implant placement/immediate implant placement
Class B (Barely sufficient bone)	6-9	5	3 or less	Osteotome/immediate implant placement
Division H (Horizontal defect)	6-9	Less than 5	3 or less	Osteotome and Ridge expansion GBR/Onlay graft/ immediate or delayed implant placement
Division V (Vertical defect)	6-9	Greater than or equal to 5	More than 3	GBR followed by Osteotome / delayed implant placement
Division C (Combined defect)	6-9	Less than 5	More than 3	GBR and/or Onlay graft followed by osteotome and delayed implant placement
Class C (Compromised Bone)	5 or less	5 or more	3 or less	Lateral wall sinus elevation/immediate or delayed implant placement
Division H (Horizontal defect)	5 or less	Less than 5	3 or less	Lateral wall sinus elevation & GBR/Onlay graft/ delayed implant placement
Division V (Vertical defect)	5 or less	Greater than or equal to 5	More than 3	Lateral wall sinus elevation & GBR followed by Onlay graft (if indicated)/ delayed implant placement
Division C (Combined defect)	5 or less	Less than 5	More than 3	Lateral wall sinus elevation & GBR followed by Onlay graft/ delayed implant placement

MAXILLARY SINUS AUGMENTATION TECHNIQUES

In the posterior maxilla, adequate bone volume is often unavailable because of severe post extraction alveolar crest resorption coupled with age-linked sinus pneumatization. For these reasons maxillary sinus lift procedures are aimed at augmenting and improving bone quality and quantity **(Chanavaz 1990)[16].**

At present, sinus floor elevation techniques require either a lateral approach, that is opening a "window" through the lateral wall of the alveolar ridge **(Boyne 1980)[9]** or a transcrestal or transalveolar approach, in which access to the sinus cavity through the edentulous bone crest is created (**Summers 1994)[99].**

Dental implant placement associated with augmentation of the sinus floor in a severely atrophied maxilla can be performed in one or two surgical stages depending on the height of the residual alveolar bone. In a one-stage procedure, a minimum base height of 4 to 5mm is recommended for adequate implant stabilization and parallelism. A two-stage approach is performed when there is insufficient residual bone. This allows healing of the graft material for future implant sites (**Smiler DG1992) [92].**

LATERAL WINDOW APPROACH

The most widely used technique for maxillary sinus floor elevation is the classical lateral window technique introduced by Tatum in 1976. In this technique, access to the maxillary sinus is obtained by drilling a bony window in the lateral sinus wall using a small round bur, while ensuring that the sinus membrane remains intact. The sinus membrane is then elevated, mobilized together with the attached bony window and rotated medially and then augmentation with autogenous bone and /or other grafting material is carried out. This procedure provided increased bone volume and height to aid in primary stabilization of one or more endosseous implants (**Tatum 1986)**[104]**.**

Disadvantages with lateral window technique:

The lateral window sinus lift remains a technique sensitive procedure due to the high risk of schneiderian membrane perforation and hemorrhagic complications, the latter of which is associated with the inadvertent laceration of the intraosseous arterial supply to this region (**Solar 1999**)[94]**.**

OSTEOTOME TECHNIQUE

Summers et al (1994)[99] developed a surgical technique using osteotomes which is indicated when the residual bone height from the sinus floor is 5 to 6 mm and the bone is of low density. Bone is compacted laterally and apically around the implant site by using osteotomes of progressively increasing diameter.

Coatoam and Krieger et al (1997)[19] used methods similar to the osteotome technique. Their method used demineralised lyophilized bone, with or without autogenous bone. Implants were placed at the same surgical visit. The authors obtained 92% success for 89 implants that were followed up for 6 to 42 months.

Zitzmann and Scharer et al (1998)[121] reported the results of three different methods of sub sinus grafts and placement of implants: two-stage appositional, one-stage appositional, and osteotome technique. 59 implants were placed in 20 patients using the osteotome technique. A success rate of 95% was reported after a mean follow-up period of 6 to 24 months. A radiographic gain of 3.5 mm was obtained with the osteotome technique. These authors considered that this technique is contraindicated where there is a bone height of less than 6mm.

Davarpanah et al (2001)[23] proposed a modified osteotome technique, in which the bone thickness below the sinus was ≥ 5mm. This technique was based on the use of a combination of osteotomes, drills, and screw-type implants with a rough surface texture. A resorbable graft material was introduced into the surgical site before using the first osteotome. This material served as a shock absorber to gently fracture the sinus floor. With each use of the osteotome to condense the material, the sinus membrane is lifted approximately by 1mm.

Toffler et al (2004)[107] evaluated the success of osteotome mediated sinus floor elevation (OMSFE) using autogenous and xenogenic bone and a variety of screw type implants in 276 sites. The mean residual bone height was 7.1mm. The mean increase in bone height of the implant site using OMSFE was 3.8mm. He concluded that OMFSE can be used predictably for implant placement at sites with moderate vertical deficiencies in the posterior maxilla.

Luciano Malchiodi et al (2011)[60] described Osteotomes with two types of working extremities: concave and convex. The concave spike mainly cuts, while the convex end deals with compression. The alternating use of concave and convex ends allows two different vectors of osteocompression. The first is directed apically while the latter is directed length wise. The author has concluded that; when unexpected bone deficiency with vestibular collapse occurs, the use of these osteotomes can restore the emerging profile of the future prosthetic manufactured product, through cortical transversal widening and spongious bone compacting.

Disadvantages with Osteotome Technique:

- The chances of achieving a sufficiently high elevation with the osteotome technique are limited (**Zitzmann NU 1998)**[121]**.**
- **Vernamonte et al (2011)**[113] reported that OSFE leads to complications, which involve local problems such as tearing of the

sinus membrane, infection, bleeding, sinusitis and benign paroxysmal positional vertigo (BPPV).

- The action of osteotomes can hardly be controlled during the application of malleting pressure resulting in an unwanted penetration of the instruments and/or graft into the sinus cavity.

- According to standard protocol, the osteotome technique cannot be used to elevate the sinus membrane more than 5 to 6 mm **(Rodoni 2005)[83].**

- **Rosario Sentineri et al (2011)[86]** suggested to avoid the usage of osteotomes, if the force required was greater than 20 MPa, so as not to cause tissue damage from excessive compression.

OTHER TECHNIQUES FOR SINUS AUGMENTATION

Trombelli et al (2010)[110] proposed the smart-lift technique characterized by transcrestal approach by means of specifically designed instruments with adjustable stop devices. 14 implants were placed in 11 patients using the proposed technique. Residual bone height was 6.1. Six months after, a newly formed mineralized tissue was found around implant. He concluded that this technique represents a suitable option to elevate the sinus floor with a limited post operative morbidity.

RoniKolerman et al (2011)[85] evaluated the long term outcome of crestal core elevation (CCE) procedure over a period of 11 years. Extraction sites were drilled with calibrated trephine bur to a distance of 1 mm from the sinus membrane. The trephined interradicular bone and the sinus membrane were imploded into the sinus. Then the crater was filled with deproteinised bovine bone mineral or FDBA. Implants were placed after 4 months. Results confirmed that the procedure had a success rate of 68.9%. He concluded that CCE implemented with molar extraction provided therapeutic benefits and the subsequent implant placement revealed excellent survival rate.

TroedhanA (2012)[109] performed A radiological Study in 14 Patients Treated with the Transcrestal Hydrodynamic Ultrasonic Cavitational Sinus Lift Intralift .The result showed bone formation under the sinus membrane and the antral floor was detected 4 months after surgery.

Sinus floor elevation using Piezoelectric Surgery:

The piezoelectric device with an ultrasonic vibration of 25 to 30 KHz, precisely cuts only mineralized structures without cutting soft tissues which remain undamaged even in case of accidental contact. The movement of piezosurgical knife is very small, so the cutting precision is greater and causes less discomfort for the patient (**Vercellotti 2006**)[112]**.**

Baldi D et al (2011)[7] reported that Piezosurgery for sinus floor augmentation using a one stepcrestal approach, where the residual bone is ≤ 7.5mm and installation of tapered implants yielded the best results.

SURVIVAL OF IMPLANTS IN SINUS AUGMENTED SITES

Summers RB (1994)[99] placed 143 implants in 55 patients at the time of performance of an osteotome sinus lift, and reported a cumulative success rate of 96% for these implants in function for 0 to 5 years. Implant success and failure rates were not examined relative to preoperative residual alveolar bone height crestal to the floor of the sinus.

Horowitz (1997)[42] placed 34 implants at the time of an osteotome sinus lift in 18 patients, and reported a 97% cumulative success rate for the implants, in function for 10 to 15 months. Horowitz reported an average gain in alveolar bone height of 3 mm following osteotome sinus lift therapy and implant placement.

Coatoam and Krieger (1997)[19] placed 89 implants in osteotome-lifted sinuses of 77 patients, and reported a 92% cumulative success rate of implants in function for 6 to 42 months. The length of the implant placed and the implant success were not evaluated in relation to residual alveolar bone crestal to the floor of the sinus preoperatively. In addition, no effort was made to document the gain in apical alveolar bone height.

Komarnyckyj and London (1998)[54] placed 16 patients following osteotome sinus lifts, and reported a 94% cumulative success rate of the implants in function for 3 to 38 months. The height of the residual alveolar bone preoperatively was 5.31 mm on the buccal and 5 mm on the palatal.

Komarnyckyj(1998)[54] reported a 3.25 mm gain in alveolar bone height of 3.38 mm on the buccal and 3.13 mm on the palatal aspect following the performance of the osteotome sinus lift procedure.

Bruschi et al (1998)[11] reported the results of 499 implants placed in 303 patients following utilization of a localized management sinus floor (LMSF) technique. While not identical, this technique is similar to the Summers osteotome technique, but does not advocate placement of bone graft material. The 499 implants placed demonstrated a cumulative success rate of 97% in function for 2 to 5 years. All patients treated presented with 5 to 7mm of residual alveolar bone coronal to the floor of the sinus preoperatively.

Zitzmann and Scharer (1998)[121] placed 59 implants in osteotome-lifted sinuses of 20 patients, and reported a 95% cumulative success rate for the implants, in function for 30 months. They reported an apical alveolar bone height gain of 3.5 mm after utilization of an osteotome procedure, and stated that a minimum of 6 mm of residual bone coronal to the floor of the sinus must be present to employ an osteotome approach with simultaneous implant placement.

Rosen et al (1999)[87] In a multicentric retrospective study that evaluated the application of the **Summers technique (1995)**[100] for placement of 174 implants in 101 patients, the survival rate was 96% when residual bone height was 5 mm or more but declined to 85.7% when residual bone height was 4mm or less

Deporter et al (2000)[26] placed 26 implants in 16 patients following osteotome sinus lift. These implants were in function for 6 to 36 months with a mean functional time of 11.1 months. All implants were functioning successfully at the time of statistical compilation. Greater than 3 mm of residual alveolar bone was present coronal to the floor of the sinus at the time of therapy, and the average implant length was 6.9 mm.Twenty-two of the 26 implants placed were 7 mm in length.

Cavicchia et al (2001)[14] placed 97 implants in 86 sinuses augmented utilizing an osteotome approach. Eight implants were mobile and three were lost in function, yielding a cumulative success rate 88.6% after 6 to 90 months in function. Patients were treated utilizing this approach only if at least 5 mm of residual bone was present coronal to the floor of the sinus preoperatively. Cavicchia reported sinus displacement of 1 to 6 mm utilizing the osteotome approach, with a mean sinus displacement of 2.9 mm apically.

Winter et al (2002)[117] reported the results of 58 implants placed in 34 patients following utilization of a LMSF technique. The cumulative success rate after 22 months of function was 91.4%. Winter et al. Treated patients who

presented with 4 mm of residual bone or less coronal to the floor of the sinus preoperatively, and reported that the sinus was "raised" an average of 9.12 mm. Four implants, or 6.9% of the implants placed, were mobile at uncover.

Fugazzotto (2002)[37] placed 116 implants in 103 patients following utilization of a modified trephine and osteotome approach to effect displacement of the sinus floor. Two implants were mobile at uncovery, and no implants had failed in function for up to 4 years, yielding a cumulative success rate of 98.3%. No implants were placed with a length greater than 2x-2, with x equaling the residual alveolar bone present coronal to the floor of the sinus at the time of therapy.

Toffler et al (2004)[107] recorded a 73.3% survival rate when the residual crest height measured 4 mm or less, versus 93.5% in the case of the total implants.

Emmerich et al (2005)[30] A systematic review evaluated the effectiveness of sinus floor elevation using osteotomes. The reviewers concluded that the short-term success rates were similar to success rates of implants conventionally placed in the partially edentulous patients (96% after 36 months).Long term outcomes (>=5 years) of implants placed with osteotome technique are still scarce. The authorsconcluded that implants placed in augmented bone through transcrestal sinus floor elevation showed a survival rate of 90.9% after 24 months of loading.

In a recent study Ferrigno et al (2006)[34], survival and success rates of 588 implants placed in 323 consecutive patients with a residual bone height ranging from 6 to 9mm were evaluated. After a mean observation period of 5 years, the survival and success rates were 94.8% and 90.8% respectively.

Fermergård et al (2008)[33] documented two failures out of 53 implants. In both cases the residual bone height measured 4 mm or less.

Tan et al (2008)[103] showed an estimated implant survival of 92.8% at a 3 year follow-up since the crestal approach of sinus floor elevation was introduced (**Tatum 1986**)**[104],** several studies have reported on this technique**.**

Pjetursson et al (2008)[77] assessed the cumulative survival rate of the osteotome-installed implants after a mean follow-up time of 3.2 years, was 97.4 %.

Bone grafts used in sinus augmentation

Sinus pneumatization, together with poor bone quality, is one of the most challenging circumstances in implantology, a condition that will restrict implant placement in such areas When these situations occur, bone grafts can be used to correct the bone deficits, allowing the placement of implants of adequate length and width (**Aguirre Zorzano LA 2007, Del Fabbro M 2004)[1,24].**

Rodolfo Jorge Boëck-Neto (2002)[82], done a Histomorphometrical Analysis of Bone Formed After Maxillary Sinus Floor Augmentation by

Grafting With a Combination of Autogenous Bone and Demineralized Freeze-Dried Bone Allograft or Hydroxyapatite. Histological evaluation revealed the presence of mature bone with compact and cancellous areas in both groups

Different graft materials with autologous bone as a benchmark have been studied successively by different authors. **Esposito et al (2008)[31],** in a review conducted within the Cochrane Collaboration organisation concluded that bone substitutes, Bio-Oss or Cerasorb could be used to replace autologous bone in sinus lift procedures in cases of extremely atrophic sinuses **Tonino Traini et al (2007)[108]** assesed Histologically and Histomorphometrically evaluated Anorganic Bovine Bone which was retrieved 9 Years After a Sinus Augmentation Procedure, The bone mineralized matrix around the Anorganic Bovine bone had collagen fibers randomly oriented and more osteocytes embedded. The results demonstrate both a high level of osteoconductivity and a "biomimetic" behavior over the long term.

Christian Beaumont (2008)[18], evaluated the use of Engineered Bone for sinus augmentation showed that Tissue-engineered bone grafts represent an appealing alternative for maxillary sinus augmentation because they eliminate the significant drawbacks associated with extra- and intraoral bone-harvesting procedures.

SINUS LIFT SURGERY WITH SIMULTANEOUS INSTALLATION OF IMPLANTS WITHOUT USE OF GRAFTS

For over 30 years, extensive experimental and clinical research has been undertaken based on the idea of necessity of grafting the maxillary sinus and great industrial investments have been made into developing products for this area. Eventually, the idea of a graftless augmentation of the maxillary sinus has evolved.

In a study by **Thor (2007)[106],** placed 44 dental implants in the maxillary sinus were followed annually for up to four years (mean 27.5 months and range 14–45 months) with a mean residual bone height ranging from 2.0–9.0 mm. The survival rate of implants evaluated after an average time of 27.5 months was 97.7%. The average amount of bone formation in the maxillary sinus was 6.5 mm. It was concluded that greater bone formation was related to longer implants installed and lower preoperative bone height in the subantral region.

Chen et al (**2007)[101]** placed 47 implants in 33 patients and evaluated after 2 years. No graft except blood was used, and preoperative bone of 7.5 ± 2.1 mm was reported (measured on panoramic X-ray). After 6 months of healing there were no failures and the average bone gain was 4.5 mm.

N.Hatano et al (2007)[71] presented a case series of 6 patients in whom successful new bone formation was found in all sinuses after a healing period of 6 months for the implants and an observation period of up to 34 months .

In a study by **D.S. Sohn et al (2008)**[21]**,** placed 21 implants inserted in 10 patients were evaluated after 6 months. All implants remained stable during the study period, and bone formation was found in both radiographic and histologic evaluations.

Recently Lin et al (2011)[45] presented a study where 44 patients with 80 implants in the maxillary sinus were followed for five years after delivery of the prosthesis. The survival rate was 100% after five years. The average residual bone height was 5.1 mm before treatment and at least 3 mm was required for inclusion. The average gained bone height after five years was 7.4 mm in the sinus.

NATURAL BONE REGENERATION-NATURAL TISSUE REGENERATION IN SINUS AUGMENTION

Maxillary sinus augmentation and bone regenerative procedures share similarities and both are coordinated processes involving various biologic factors (**Huang 2005)**[44]**.** Blood supply and angiogenesis play a important role in guided bone formation **(Degidi 2006)**[24]. Indeed blood clot contains many growth factors, such as fibroblast growth factor, transforming growth factor, bone morphogenetic proteins, insulin-like growth factor, platelet-derived

growth factor, and vascular endothelial growth factor, which are expressed during skeletal development and induced in response to injury. These factors are believed to regulate the repair of bone tissue.

Lundgren et al. (2004)[62], and Srouji et al (**2009)[95] i**n vivo and suggest the Schneiderian membrane to be the primary carrier of bone reformation in Sinus lift procedures providing the necessary osteoprogenitor cells and humoral factors for bone regeneration.

The first histological evidence to describe this special bone formation was published by **Palma et al 2006 [74],** where blood alone or autogenous bone graft in a sinus lift study in four primates were compared. Both test and control sides revealed no differences in bone formation, but the importance of the implant surface characteristics became evident as well as the bone forming capacity of the Schneiderian mucous membrane

Sul et al (2008)[98] evaluated different lengths of installed implants into the sinus cavity. They could see no difference on bone formation using 4 and 8 mm implants.

Johansson et al[50] recently reported on the use of a hollow hydroxyapatite space-maintaining device in three patients for preventing the clot collapsing and enabling bone regeneration and subsequent implant installation.

GiovannaOrsiniin (2006)[39], assessed Histologically and Ultrastructural Analysis of Regenerated Bone in Maxillary Sinus Augmentation Using a Porcine Bone–Derived Biomaterial showed that under light microscopy (LM) and transmission electron microscopy (TEM) showed that most of the particles were surrounded by newly formed bone. In some areas, the osteoid matrix was present; Under TEM, all phases of bone formation (osteoid matrix, woven, and lamellar bone) were observed in proximity with the biomaterial particles

RoniKolerman 2008, Histomorphometric Analysis of Newly Formed Bone after Maxillary Sinus Floor Augmentation Using Ground Cortical Bone Allograft and Internal Collagen Membrane**:** Histologic evaluation revealed a mean of 29.1% newly formed bone, 51.9% connective tissue, and 19% residual graft material. FDBA is biocompatible and osteoconductive when used in maxillary sinus augmentation procedures, and it may be used safely without interfering with the normal reparative bone process

Srouji and co-authors (2009)[96] recently attempted to explain histologically the formation of bone beneath the sinus membrane on the maxillary sinus floor by exploring the osteogenic potential of the Schneiderian maxillary sinus membrane proved the cells capable of inducing and expressing different osteogenic markers including alkaline phosphatase, bone morphogenic protein-2, osteopontin, osteonectin, and osteocalcin and of further mineralizing their extracellular matrix.. The deeper layers of the

membrane, with periosteum-like structure, and microvascular cells within the membrane may both serve as sources for the osteogenic capacity of the membrane and subsequent bone formation

Cricchio et al (2011)[20] presented a study where 189 implants had been installed in the maxillary sinus in 84 patients. A two-stage technique was used in the majority of the cases. The range of the followup was 1–6 years. The survival rate was 98.7%, and the average new bone formation was 5.3 mm after 6 months of healing. Resonance Frequency Analyses showed adequate primary stability and small changes over time.

METHODOLOGY

Patient Selection

The study included a total of 8 patients (10 sites), 5 males and 3 female, aged between 25 to 55yrs who were referred to the Department of Periodontics, Ragas Dental College and Hospital, Chennai for implant placement in the edentulous posterior maxilla. Informed written consent to participate in this study was obtained from all patients, in particular explaining the objectives and protocol of the study, and possible side effects.

Inclusion Criteria

Patients were selected using the following criteria:

1. With a unilateral or bilateral loss of teeth in the maxillary pre-molar or molar area.
2. Crestal bone height greater than 5mm below the sinus floor as determined by an OPG.
3. Patients with Class B, division – V (Vertical Defect) were included (ABC classification by **Hom-Lay Wang 2008**)[41].
    a. The bone crest is 6 to 9mm from the sinus floor.
    b. The bone width is 5mm or more.
    c. The bone crest is more than 3mm from the adjacent CEJ.

4. Patients with good oral hygiene and without any active periodontal disease were selected.

Exclusion Criteria

1. Systemic conditions such as uncontrolled Diabetes Mellitus, Hypertension or any other contra-indicating systemic complications.
2. Patients with Immune suppression and bleeding disorders.
3. Patients with Oro-facial cancer, chemotherapy or head and neck radiotherapy twelve months prior to the surgery.
4. Any pathological lesion in the sinus (benign or malignant tumor, mucocele or active sinusitis).
5. Untreated active periodontitis in neighboring teeth.
6. Patients with long term steroid therapy or bisphosphonate medication.
7. Patients who are not current smokers.
8. Pregnant women and nursing mothers.
9. Any previous history of sinus surgery.
10. Patients with any drug abuse including alcohol.

Pre Operative Diagnostic Evaluation

Clinical Examination

At the initial visit, all patients underwent a clinical and occlusal examination. An oral hygiene assessment of the patient was performed. Periodontal health status was assessed for the neighboring teeth on either side of the edentulous ridge.

The edentulous area in the posterior maxilla was examined and the ridge width and mesio-distal and interocclusal distance were measured. Patients who had an adequate ridge width, interdental and interocclusal distance were further evaluated radiographically, for the availability of Residual bone height.

Radiographic examination

Pre procedural panoramic radiographs were used to assess the Residual bone height (RBH) below the sinus lining. Digital Periapical radiographs (RVG) were taken before the procedure was initiated.

Three reference points Point A, Point B, Point C were considered preoperatively

- Point A- 2mm from the mesial tooth.
- Point B- Midpoint from the line joining point A & C.
- Point C- 2mm from the distal tooth.

From these 3 points mentioned above, vertical arbitrary lines were drawn to the floor of the maxillary sinus and the values were recorded

In the radiographic examination the length of implant protruded into sinus is measured from sinus floor to implant apex (B1-B2) at a standardized point using both OPG and RVG at Baseline, 3 months and 6 months.

Crestal bone height was evaluated with a series of digital periapical radiographs and OPG at baseline, 3 and 6 months. Radiovisiograph (RVG) with software, SOPRO, was used for this purpose including measurement of crestal bone height to resolution level up to 0.00 mm. The methodology of obtaining radiographs was standardized with placing the cone at the angulation of $+20^0$ using bisecting angle technique. The patient's position was standardized with the upper arch parallel to, and midsagittal plane perpendicular to the floor. Each radiovisiograph was calibrated by calculating the length of each implant in order to evaluate a normalized factor, avoiding magnification and alterations to implant data.

Crestal bone height is assessed in three Groups at proximal surface of implant at Baseline, 3 months and 6 months. Group I is from implant collar to first crestal bone contact. Group II is from first implant thread to crest both were assessed using RVG. Group III is measured from adjacent tooth CEJ to alveolar crest using OPG.

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Pre-Operative Casts and Bone Mapping

An impression of the maxillary arch and mandibular arch using alginate impression was taken and cast was obtained. The upper and lower cast was articulated to determine the final position of implant prosthesis. Wax try in was done. The upper cast was given for die-cutting. Bone mapping was done to determine the width of the alveolar ridge using acrylic stent with holesmade at the crest, 2 mm from the crest and 4mm from crest both buccally and palatally. Measurements are transferred to the cast and width of the alveolar ridge is obtained. Prior to surgery, a surgical template was made up of clear acrylic was used and a metal sleeve was used to decide the location of implant placement

ARMAMENTARIUM

DIAGNOSTIC INSTRUMENTS

1. Mouth mirrors
2. Graduated William's probe
3. Tweezers
4. Metal ball stent

SURGICAL INSTRUMENTS

1. 2 ml disposable syringe (Unolock)
2. 2% Lignocaine hydrochloride with 1:80,000 adrenaline
3. Bard parker handle No.3
4. Bard parker blade No.15
5. Periosteal elevator (Goldmann fox)
6. Austin cheek retractor
7. Curved Goldmann fox scissors
8. Needle holder
9. Suture cutting scissor
10. Tissue forceps

11. Kidney tray
12. Stainless steel bowl-2
13. 3-0 Silk suture
14. 20 ml saline (irrigation) syringes
15. Normal physiological saline (0.9%W/V)
16. Round surgical bur
17. Pilot drill bur (2.0 mm)
18. Contra angle hand piece
19. Metal suction tip
20. Osteotomes (2.2- 3.7 mm)-UnitiBone expanders
21. Zimmer Implant (3.7 mm diameter X 10 mm length)
22. Zimmer Implant Kit
23. Mallet
24. Povidine-iodine solution
25. Physio - dispenser with internal irrigation system

SURGICAL TECHNIQUE

All patients were subjected to prophylactic antibiotic coverage (Amoxicillin 2gms) 2 hours, prior to sinus floor augmentation procedure. They were made to rinse their mouth with 0.2% chlorhexidine gluconate for 2 minutes, prior to surgery. The face and surgical site were wiped with Povidine Iodine (Betadine) solution.

Local anesthesia (2% Lignocaine with 1:80,000 adrenaline) was administered to the patient. Posterior and middle superior alveolar nerve block along with greater palatine nerve block was given to ensure complete anesthesia of the surgical site.

An alveolar mid-crestal horizontal incision was performed in the edentulous siteand connected with the sulcular incision of adjacent teeth. Muco-periosteal flap was elevated exposing alveolar crest of the bone. No vertical releasing incision was employed and the flap was reflected not exceeding the alveolar ridge.

Surgical template was used to guide the round bur. Cortical perforation was done using a round bur, followed by the pilot drill of 2mm and 2.8mm reaching about 1mm short of the sinus floor. After radiographic verification of the sinus floor with the digital periapical radiographs, sequential expansion of the osteotomy site was achieved using a series of osteotomes in graduated diameters, to laterally condense the low density maxillary bone.

In all cases, implant site preparation is completed to 2mm less than the diameter of implant. This under preparation ensures increasing lateral pressure of the implant on the site because of typical elasticity of maxillary bone tissue leads to primary stability. Hence osteotome diameter used initially was 2 mm followed by 3.3 mm diameter and finally 3.7 mm diameter Implant was placed to gain primary stability.

After examining the integrity of sinus membrane by Valsalva maneuver; digital periapical radiograph was taken to assess the sinus elevation made using osteotome.

Once the desired elevation (usually greater than 10 mm) was obtained, Zimmer dental implant of 3.7 mm diameter and 10 mm length was inserted into osteotomy site using hand screw driver till coronal first thread of implant into the bone. Hexdriver is used to unscrew the abutment.The cover screw was then placed, the implants were covered with the mucosa and sutures were placed. After 7 days sutures were removed.

After the sinus floor augmentation procedure was completed, the muco-periosteal flap was repositioned and closed with simple interrupted sutures, using 3-0 silk suture material.

OPG and RVG is taken at the time implant placement, 3 months and 6months to evaluate radiographically length of implant protruded into sinus and crestal bone height.

After 6 months prior to implant exposure OPG and RVG were made to assess for osseointegration. After satisfactory results, implant was exposed and covered with the healing cap, so as to get proper contour of the gingiva.

After a healing period of 6 months, a two stage implant surgery was planned. Second surgery was performed 6 months later. After a week abutment was placed which acts like transfer coping and final one stage impression was made using putty and light body hydrocolloid impression material to get a master cast

Wax pattern was fabricated and casted and a metal framework was obtained. Final prosthetic loading was done 2 weeks after the second surgery. Implant supported metal ceramic fixed prosthesis was fabricated and cemented with type I Glassinomer cement and occlusion was analyzed for centric occlusion and centric relation. High points are identified using articulating paper and reduced for harmonious functional occlusion

Post Operative Instructions

Patients were instructed to refrain from blowing their nose for 2 weeks to prevent increased pressure in the operated sinus. They were also instructed to avoid sneezing or coughing, just to ensure that the surgical site remained undisturbed during the initial stages of healing. Patients were instructed to avoid wearing their removable prosthesis and were advised to follow a soft diet.

Systemic antibiotic therapy comprised of Amoxycillin, 500 mg three times per day for 5 days after surgery. Anti-inflammatory analgesics (Ibuprofen) 400mg three times a day was prescribed for 5 days. The patients were instructed to rinse twice daily with 0.2% chlorhexidine gluconate mouth rinse for 2 weeks. Patients were examined after a week and suture removal was done.

Post Operative Radiographic Evaluation

During follow-up period of 3 months and 6 months the length of implant protruded into sinus and crestal bone height are assessed using both RVG and OPG.

Postoperative implant survival:

Implant survival is assessed over a period of 6 months using The survival criteria proposed by Buser et al. and Cochran et al. were assessed clinically and radiographically: (i) absence of clinically detectable implant mobility, (ii) absence of pain or any subjective sensation, (iii) absence of recurrent periimplant infection, (iv) absence of continuous radiolucency around the implant Radiographic evaluation using panaromic radiographs and digital periapical radiographs were taken at the time of implant placement, 3 months and 6 months. They were analyzed by the same investigator.

Postoperative Surgical Complications:

Postoperative surgical complication related to sinus lift osteotome procedure like postoperative pain, swelling, discharge from nose (fluid, blood, bone sequestrum), Benign paroxysmal positional vertigo, sinus perforation, sinusitis, oral-antral fistula is recorded.

Postoperative Implant Maintenance

Patient was instructed about the maintenance of oral hygiene by means of dental floss, interdental brush and mouth wash. Also patient was recalled after 1 week and 1 month.

RAGAS DENTAL COLLEGE AND HOSPITAL,CHENNAI.

DEPARTMENT OF PERIODONTICS

PROFORMA

PATIENT NAME :
DATE :

OP NUMBER :

AGE/SEX :

ADDRESS :

CONTACT NUMBER :

MARITAL STATUS :

OCCUPATION :

CHIEF COMPLAINT :

HOPI :

MEDICAL HISTORY :

PAST DENTAL HISTORY :

HABITS :

FAMILY HISTORY :

CLINICAL EXAMINATION :

EXTRA ORAL :

INTRA ORAL :

HARD TISSUE EXAMINATION :

MISSING TOOTH :

BLOOD INVESTIGATIONS

BLEEDING TIME :

CLOTTING TIME :

WBC-TOTAL COUNT :

WBC –DIFFERENTIAL COUNT : N- ; L - ; E- ; M- ; B -

HEMOGLOBIN % :

RBS :

ESR :

RADIOGRAPHS

IOPA

OPG

Pre-Surgical Procedure for Implant placement

A) Study Model

Mesio-lingual width:

Interocclussal gap:

B) Surgical stent:

C) Bone Mapping

Done

Not done

If done available bone width:

Other observation:

TREATMENT PLAN:

SINUS FLOOR AUGMENTATION WITH SIMULTANEOUS IMPLANT PLACEMENT IN RELATION TO:

Measurement of Length of Implant Protruded into Sinus

Length of implant protruded into sinus	Residual bone height(mm)	Baseline (mm)	Post - operative 3 months (mm)	Post-operative 6 months (mm)
OPG				
RVG				

Measurement of crestal bone Height

	Baseline (mm)		3 months		6 months	
	Mesial	Distal	Mesial	Distal	Mesial	Distal
Group I						
Group II						
Group III						

Evaluation of Postoperative osteotome Sinus lifts Procedure Complication

Postoperative Complication	Present	Absent
Postoperative Swelling		
Postoperative Pain		
Discharge from nose (Fluid,Blood,Bonesequestrum)		
Benign Paroxysmal positional vertigo		
Sinus perforation		
Sinusitis		
Oraantral Fistula		

Assessment of Implant Survival criteria proposed by Buser and Cochrane

Survival Criteria	Present	Absent
Clinically detectable implant mobility		
Clinically detectable implant mobility		
Recurrent periimplant infection		
Continuous radiolucency around the implant.		

Survival of IMPLANT

CASE NO#	3 months Survival	6 months survival

IMPLANT PLACEMENT:

A) Total no of Implants :

B) Site and size & type :

C) Single/Two stage :

D) Any Adjacent procedure :

CONSENT FORM

PATIENT NAME :

AGE / SEX :

I have been informed that I need to undergo sinus elevation procedure before implant placement. I have no objection for undergoing the treatment and if the treatment shows no anticipated results I agree to undergo suitable /alternative method for the same. I give my consent for photographs to be taken at the beginning, during, and end of the study.

I understand that I am free to withdraw my consent without any effect to my treatment

STATION :

DATE :

SIGNATURE OF THE PATIENT :

SIGNATURE OF THE OPERATOR :

SIGNATURE OF THE HOD/GUIDE :

ARMAMENTARIUM

Fig.1a: Surgical Instruments

Fig.1b: Physio-Dispenser with Internal Irrigation System

Fig.1c: Osteotomes (Bone Expanders)

Fig.1d: Zimmer Implant Kit

Fig.1e: Zimmer Dental Implant

INDIRECT SINUS LIFT WITH SIMULTANEOUS IMPLANT PLACEMENT

Case No.1: Clinical View of the surgical procedure

Fig.2a: Pre-operative (buccal view)

Fig.2b: Pre-operative (occlusal view)

Fig.2c: Crestal Incision given &Mucoperiosteal Flap Elevated

Fig.2d: Osteotomy Site Prepared using Pilot Drill

Fig.2e: Osteotomy Site Prepared Using 2.3mm Drill

Fig.2f: Osteotomy Site Prepared Using 2.8mm Drill

Fig.2g: Osteotome used to lift sinus floor

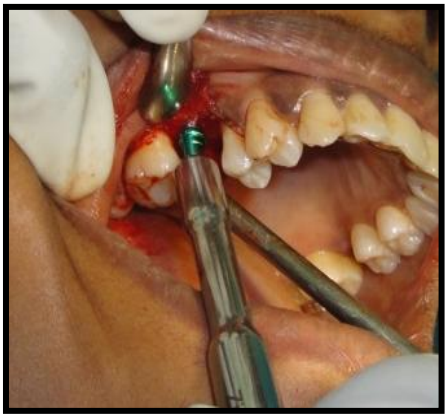


Fig.2h: Implant placed into osteotomy site

Fig.2i: Implant placement with cover screw

Fig.2j: Simple interrupted suture given

Case No.1: Radiographic view of the surgical Procedure

Fig.2k: Pre-operative View

Fig.2l: Pilot drill placed

Fig.2m: Osteotomy site prepared using drill

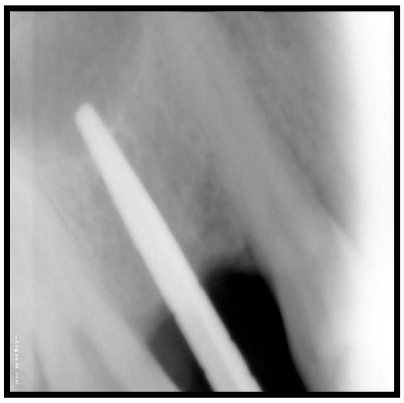


Fig.2n: Osteotomes used to lift the sinus floor

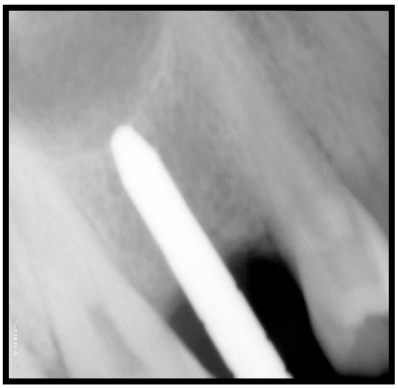


Fig.2o: Osteotome used to lift the sinus floor

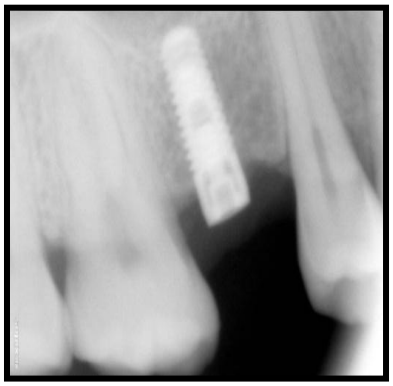


Fig.2p: Implant placement done

Fig.2q: Post-operative view
3 months

Fig.2r: Post-operative
6 months with final prosthesis

Case No.1: Measurement of implant length protuded into sinus and crestal bone changes using OPG

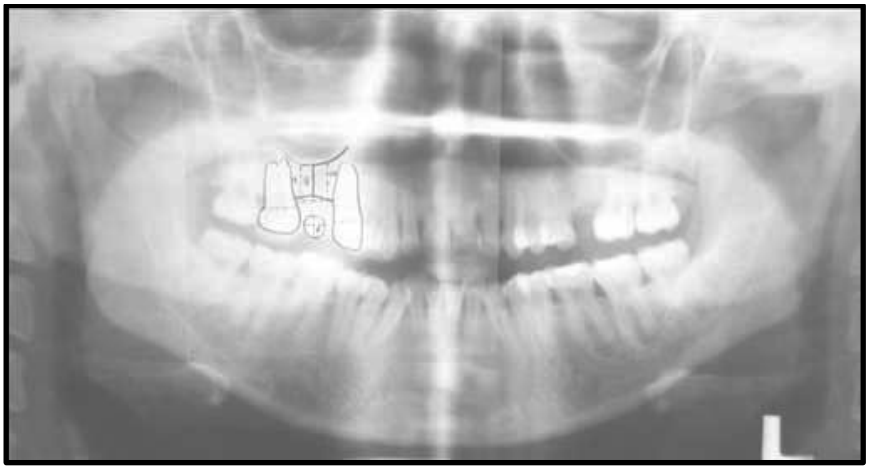


Fig.2s: OPG Pre-operative

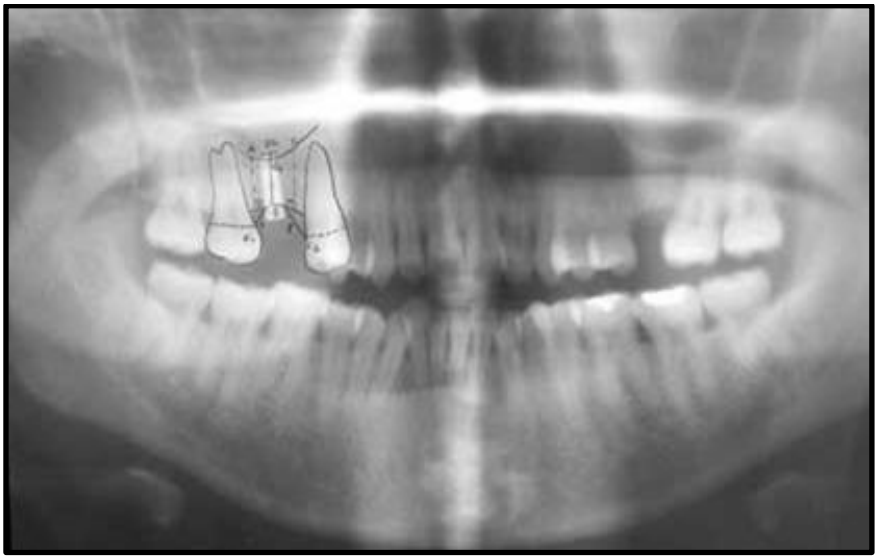


Fig.2t: Immediate Post-operative OPG

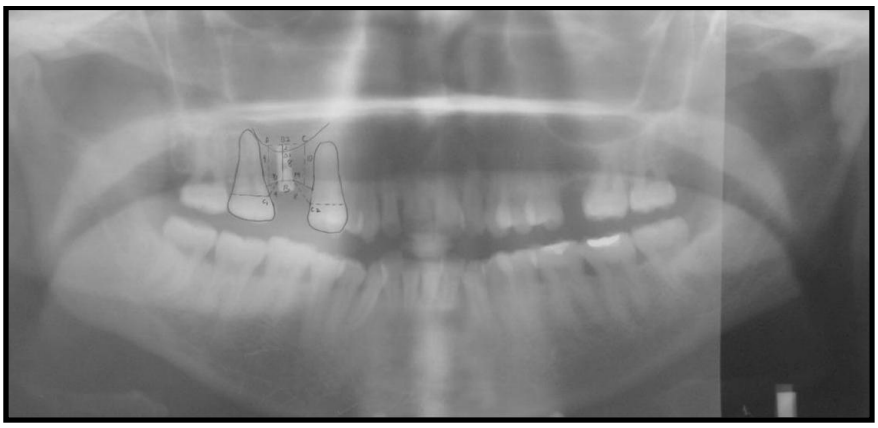


Fig.2u: Post-operative OPG(3 Months)

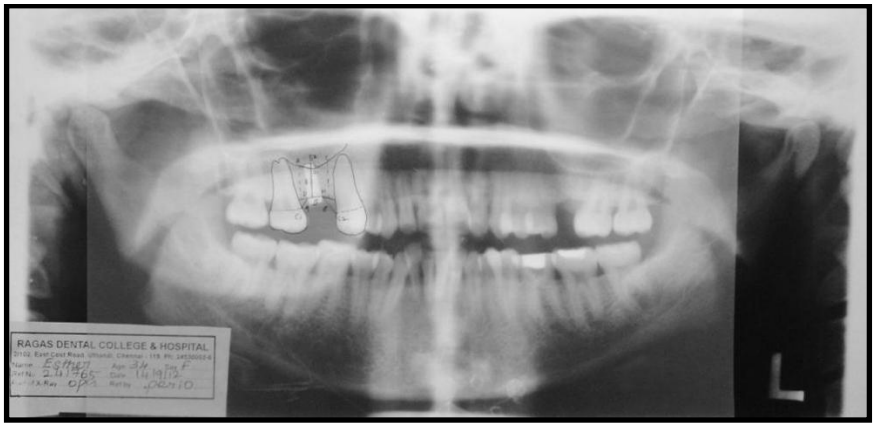


Fig.2v: Post-operative OPG (6 Months)

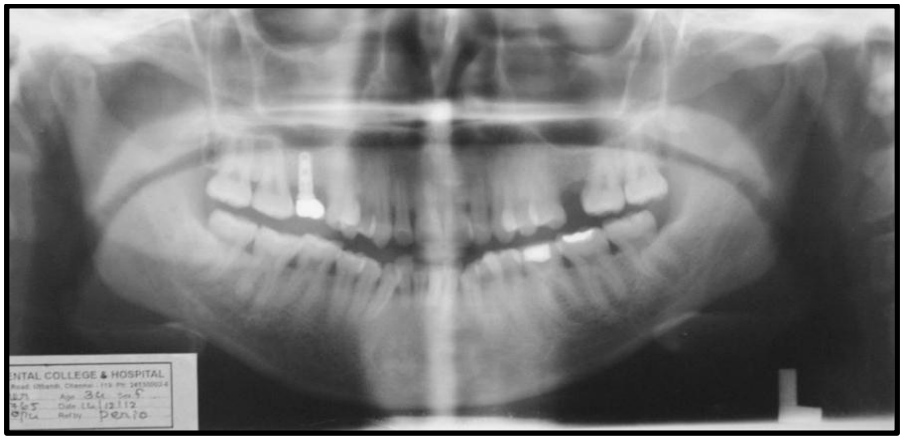


Fig.2w: Implant Loaded after 6 Months

CLINICAL POST OPERATIVE VIEW

Case No-1

Fig.2x: Immediate post operative

Fig.2y: Post-operative view 3 months

Fig.2z: post-operative view 6 months

Fig.2z(i): Healing cap placed

Fig.2z(ii): Final impression taken

Fig.2z(iii): Final prosthesis (buccal view)

Fig.2z(iv): Final prosthesis (occlusal view)

Case No.2: Clinical view of the Surgical Procedure

Fig.3a: Pre-operative view

Fig.3b: osteotomy site prepared using drill

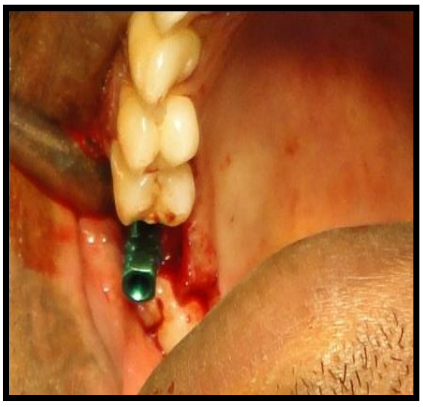


Fig.3c: Implant placed

Fig.3d: Implant placement with cover screw

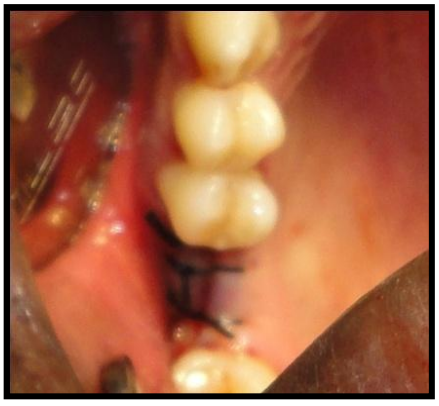


Fig.3e: Simple interrupted suture given

Case No.2: Radiographic view of the Surgical Procedure

Fig.3f: Pre-operative view

Fig.3g: Guiding pin placed

Fig.3h: Osteotomy site prepared using drills

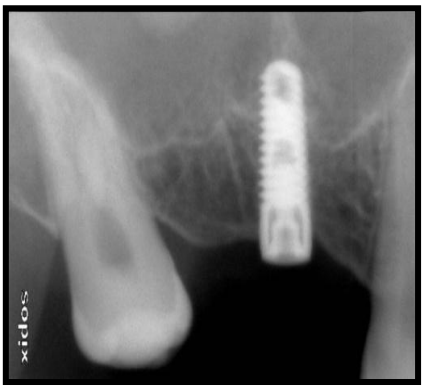


Fig.3i: Sinus Floor elevated using Osteotome

Fig.3j: Implant placement done

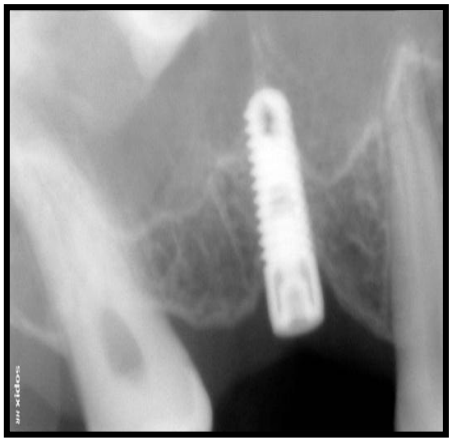


Fig.3k: Post-operative (3 months)

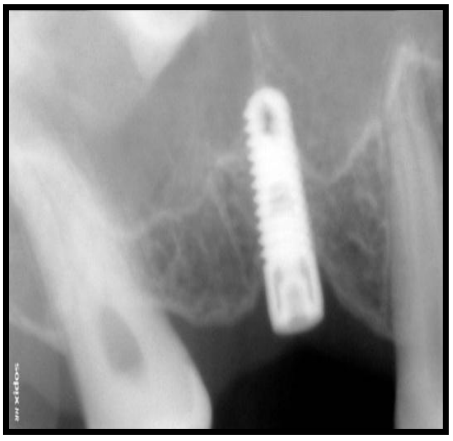


Fig.3l: Post-operative (6 months)

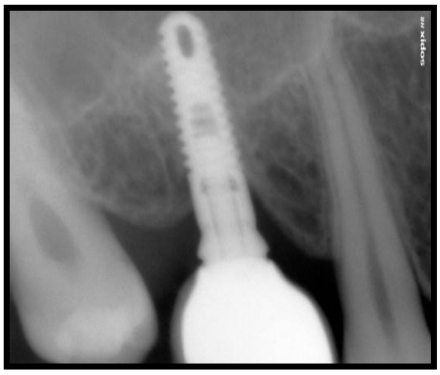


Fig.3m: Implant loaded after 6 months

Case No.2: Measurement of implant length protuded into sinus and crestal bone changes using OPG

Fig.3n: OPG Pre-operative

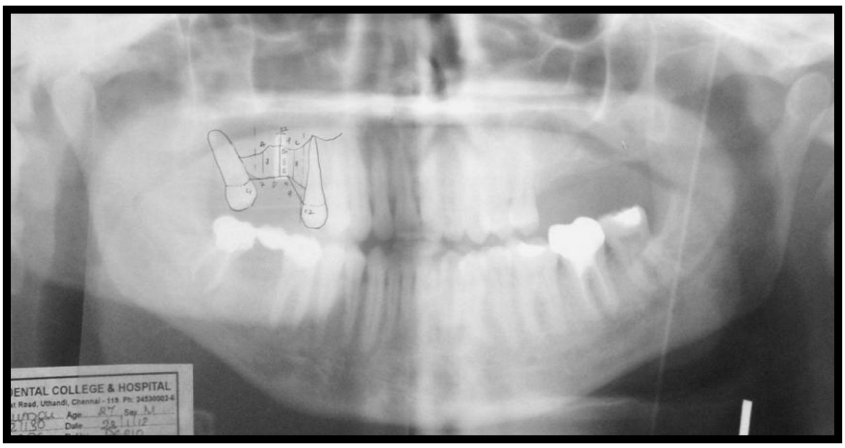


Fig.3o: Immediate Post-operative OPG

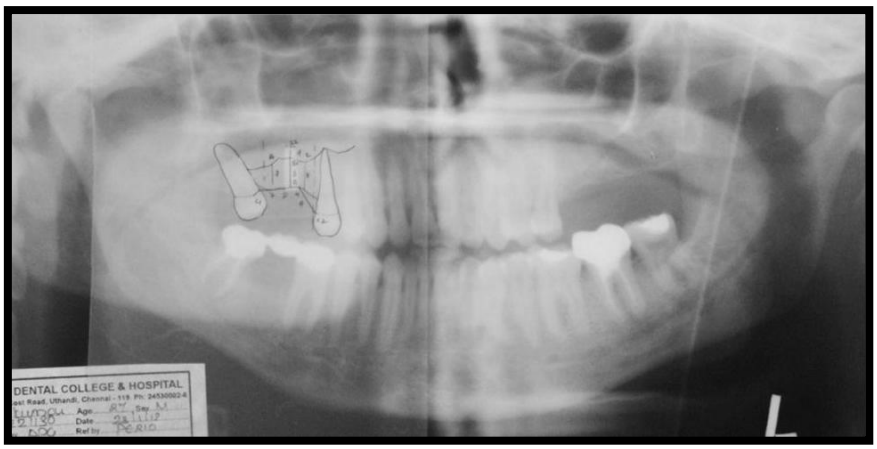


Fig.3p: Post-operative OPG(3 Months)

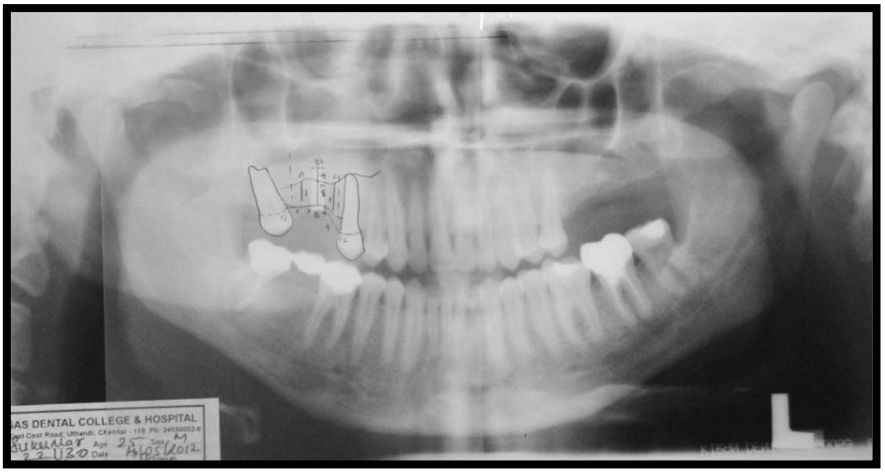


Fig.3q: Post-operative OPG(6 Months)

Fig.3r: Implant Loaded After 6 Months

CLINICAL POST OPERATIVE VIEW

Case No-2

Fig.3s: Post-operative view 3 months

Fig.3t: Post-operative view 3 months

Fig.3u: Healing cap placed

Fig.3v: Final impression taken

Fig.3w: Final prosthesis (buccal view)

Fig.3x: Final prosthesis (occlusal view)

Case No.3: Clinical view of the Surgical Procedure

Fig.4a: Pre-operative (buccal view)

Fig.4b: Pre-operative (occlusal view)

Fig.4c: Crestal Incision Placed &Mucoperiosteal Flap Elevated

Fig.4d: Osteotome used to lift sinus floor

Fig.4e: Implant placed into osteotomy site

Fig.4f: Simple interrupted suture placed

Case No.3: Radiographic view of the surgical Procedure

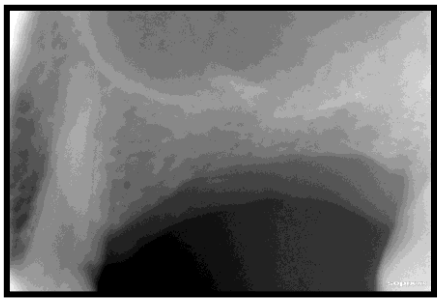


Fig.4g: Pre-operative View

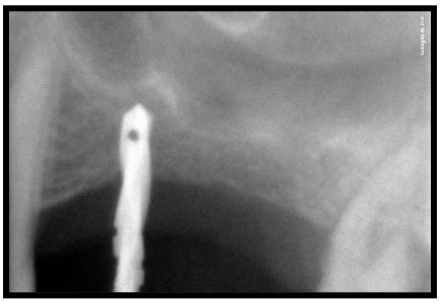


Fig.4h: Osteotomy site prepared using 2.3mm drill

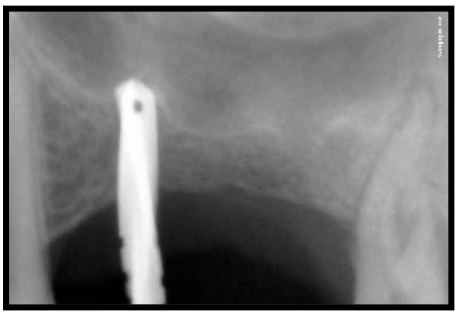


Fig.4i: Osteotomy site prepared using 2.8mm drill

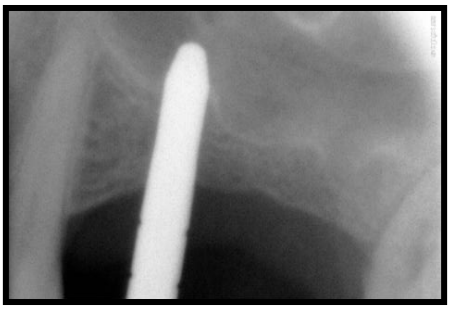


Fig.4j: Osteotome used to lift the sinus floor

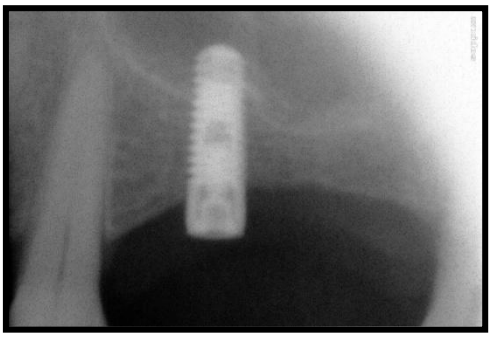


Fig.4k: Implant placement done

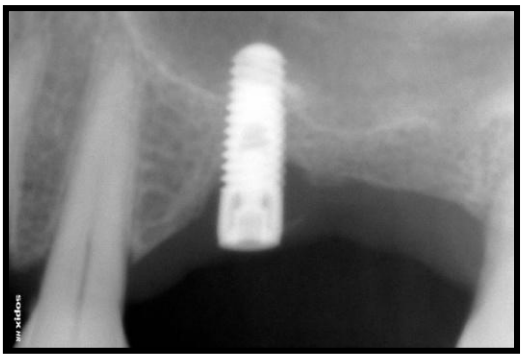


Fig.4l: post-operative view
3 months

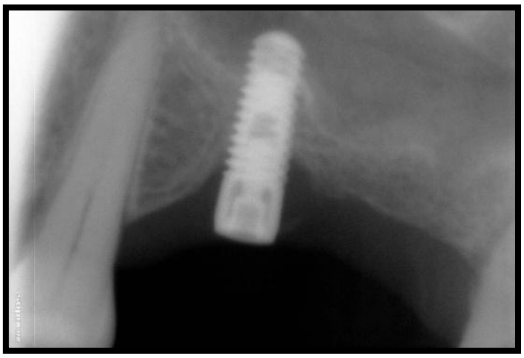


Fig.4m: Post-operative view
6 months

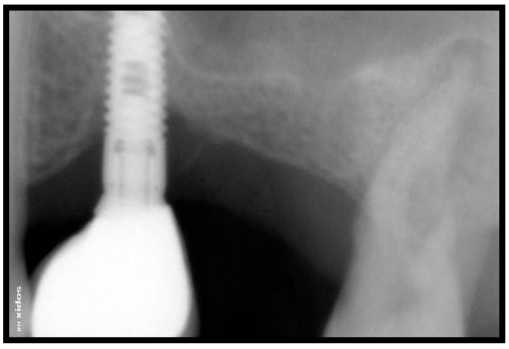


Fig.4n: Implant loaded after
6 months

Case No.3: Measurement of implant length protuded into sinus and crestal bone changes using OPG

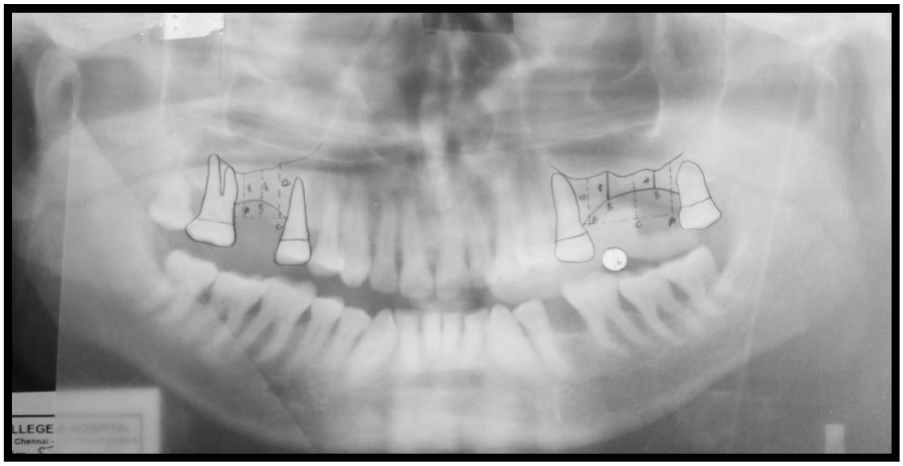


Fig.4o: OPG Pre-operative

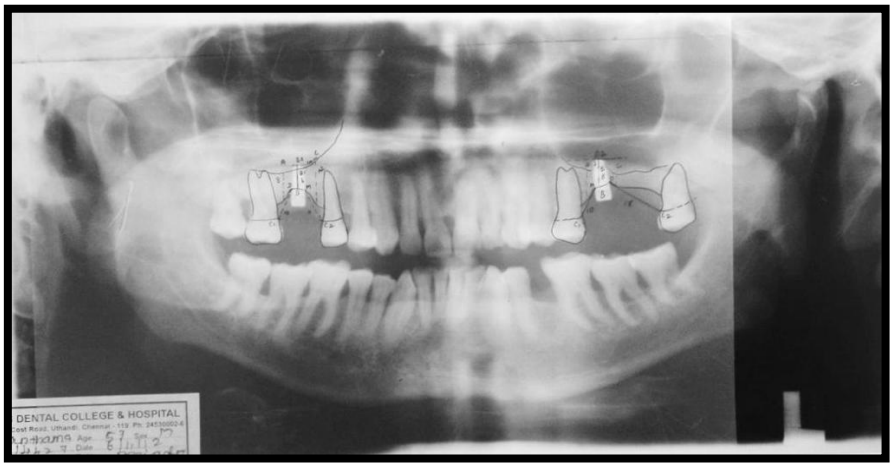


Fig.4p: Post-operative OPG 3 months

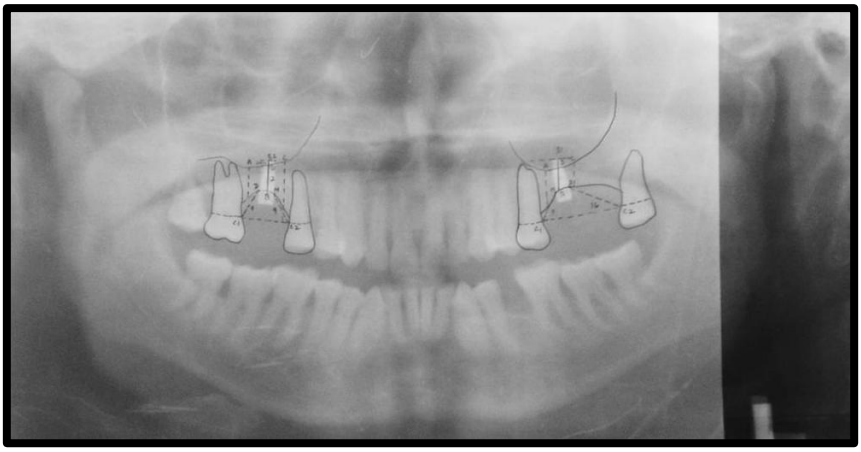


Fig.4q: Post-operative OPG (6 Months)

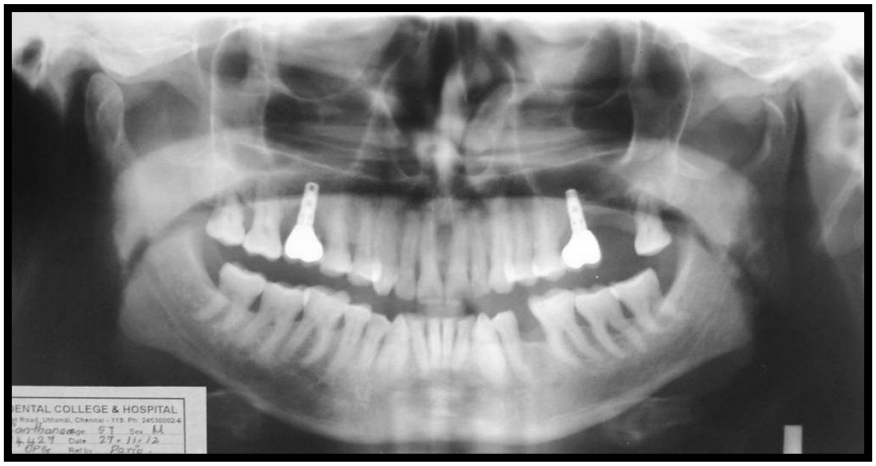


Fig.4r: Implant Loaded after 6 Months

CLINICAL POST OPERATIVE VIEW

Case No-3

Fig.4s: Post-operative view 3 months

Fig.4t: Post-operative view 6 months

Fig.4u: Healing cap placed

Fig.4v: Final impression taken

Fig.4w: Final prosthesis (buccal view)

Fig.4x: Final prosthesis (occlusal view)

RESULTS

A total of 10 indirect sinus lift procedure using osteotomes with simultaneous placement of implant measuring uniform length of 10mm and diameter of 3.7 mm was selected according to the ridge width. This technique was performed in 8 patients (two patient underwent bilateral sinus augmentation). Each site is considered as a single patient for statistical purpose. Among the 10 patients; 9 patients completed a 6months follow-up, with two implant failure and 3 months follow up for one of the patient.

The length of implant protruded into sinus measured from sinus floor to implant apex (B1-B2) at a standardized point B was evaluated using panoramic radiographs and digital Radiovisiography, at baseline, 3 months and 6 months follow-up period. Crestal bone height was also observed in three groups at the proximal surface of implant. Group I is from implant collar to first crestal bone contact. Group II is first implant thread to crest both were assessed using RVG. Group III is measured from adjacent tooth CEJ to the alveolar crest using OPG, and the results were analyzed.

The measurement of length of implant protruded into sinus at a standardized point B using OPG is outlined in Table 1

The measurement of length of implant protruded into sinus at a standardized point B using RVG is outlined in Table 2

The measurement of crestal bone height from implant collar to first crestal bone contact using RVG (GROUP I) is outlined in Table 3.

The measurement of crestal bone height from implant thread to crestal RVG (GROUP II) is outlined in Table 4.

The measurement of crestal bone height from adjacent tooth CEJ to alveolar crest using OPG (GROUP III) is outlined in Table 5.

The survival of implant at 3 months and 6 months is outlined in Table 10.

STATISTICAL ANALYSIS

The Mean and Standard Deviation of the radiographic measurement of length of implant protruded into sinus at a standardized point were analyzed using SPSS version 12.0 software.

Anova and post hoc test were used to analyze the measurement of length of implant protruded into sinus at Baseline, 3 months, 6 months outlined in Table 6.

Paired t test is used to compare the length of implant protrusion into sinus at different time intervals using OPG and RVG outlined in Table 7.

Anova and Post Hoc test is used to analyze the measurement of crestal bone height in Group I, GROUP II using RVG outlined in Table 8.

Anova and Post Hoc test is used to analyze the measurement of crestal bone height in Group III using OPG outlined in Table 9.

Interpretation of results:

Measurement of mean implant protrusion into the sinus at different time intervals using OPG and RVG.

A) In OPG baseline value was 2.5mm (n=10). At 3 months post-operatively it was 2.1mm (n=8) and in 6 months it was 2.20 mm (n=7). P value >0.05 statistically non significant.
B) In RVG baseline value was 2.4mm (n=10). At 3 months post-operatively it was 1.75mm (n=8) and in 6 months it was 1.86 mm (n=7). P value >0.05 statistically non significant.

Comparison of Mean implant protrusion into the sinus at different time intervals

A) In OPG comparison between different time interval between baseline, 3 months and 6 months was statistically insignificant (P>0.05)
B) In RVG comparison between different time interval between baseline, 3 months and 6 months was statistically insignificant (P>0.05)

Measurement of Mean crestal bone height in Group I and Group II using RVG

A) The mean Mesial crestal bone height in Group I was 2.1 at baseline and consistently increased to 3.3mm and 4mm at six months which was statistically significant P<0.005 significant at 1% level.

B) The mean distal crestal bone height in Group II was 2.5 at baseline, 3.35 mm at 3 months and 4mm at 6 months. P value was not significant.

C) In Group II mean mesial and distal crestal bone height was statistically not significant.

Measurement of Mean crestal bone height in Group III using OPG

A) Mesial mean crestal bone height at baseline was 7.20mm ,at 3 months 7.13mm and at 6 months 8mm.Pvalue >0.05 was statistically not significant.

B) Distal mean crestal bone height was 7.7mm at baseline, 9mm at 3 months and 10.14 mm at 6 months. P value >0.05 was statistically not significant.

TABLE 1.

MEASUREMENT OF LENGTH OF IMPLANT PROTRUDED INTO SINUS AT A STANDARDISED POINT B USING OPG

CASE NO #	Length of Implant Protruded into Sinus		
	Baseline (mm) B-B1	3 Months(mm) B1-B2	6months(mm) B1-B2
No.1	3	3	3
No.2	4	4	4
No.3	1	1	1
No.4	2	2	2
No.5	4	-	-
No.6	1	1	1
No.7	3	3	3
No.8	2	2	2
No.9	4	-	-
No.10	1	1	-

TABLE 2.

MEASUREMENT OF LENGTH OF IMPLANT PROTRUDED INTO SINUS AT A STANDARDISED POINT USING RVG

CASE NO #	Length of Implant Protruded into Sinus		
	Baseline (mm)	3 Months(mm)	6months(mm)
No.1	3	3	3
No.2	3	3	3
No.3	1	1	1
No.4	1	1	1
No.5	5	-	-
No.6	1	1	1
No.7	3	3	3
No.8	1	1	1
No.9	5	-	-
No.10	9	1	-

TABLE 3.

MEASUREMENT OF CRESTAL BONE HEIGHT FROM IMPLANT COLLAR TO FIRST CRESTAL BONE CONTACT USING RVG(GROUP I)

CASE NO #	Implant Placement Baseline (mm)		3 Months(mm)		6 Months(mm)	
	Mesial	Distal	Mesial	Distal	Mesial	Distal
No.1	0	0	4	3	4	3
No.2	1	1	3	3	3	3
No.3	2	3	4	4	4	5
No.4	3	3	4	3	4	3
No.5	4	4	-	-	-	-
No.6	2	2	4	5	4	5
No.7	2	3	2	3	5	5
No.8	2	2	3	2	3	3
No.9	3	5	-	-	-	-
No.10	2	2	3	3	--	--

TABLE 4.

MEASUREMENT OF CRESTAL BONE HEIGHT FROM FIRST IMPLANT THREAD TO CREST USING RVG(GROUP II)

CASE NO #	Implant Placement Baseline (mm)		3 Months(mm)		6 Months(mm)	
	Mesial	Distal	Mesial	Distal	Mesial	Distal
No.1	3	3	0	0	0	-1
No.2	2	2	1	2	1	2
No.3	2	1	1	1	1	1
No.4	2	2	1	2	1	1
No.5	0	0	-	-	-	-
No.6	1	1	-1	0	-2	-1
No.7	2	1	1	-1	0	-2
No.8	2	2	2	2	3	3
No.9	1	-1	-	-	-	-
No.10	3	2	3	2	--	--

TABLE 5.

MEASUREMENT OF CRESTAL BONE HEIGHT FROM ADJACENT TOOTH CEJ TO ALVEOLAR CREST USING OPG (GROUP III)

CASE NO #	Implant Placement Baseline (mm)		3 Months(mm)		6 Months(mm)	
	Mesial	Distal	Mesial	Distal	Mesial	Distal
No.1	5	2	8	4	9	5
No.2	9	7	9	7	10	8
No.3	6	9	7	9	7	10
No.4	6	11	7	11	7	11
No.5	13	2	-	-	-	-
No.6	8	8	9	9	10	11
No.7	9	16	9	16	10	18
No.8	4	8	4	8	4	8
No.9	8	6	-	-	-	-
No.10	4	8	4	8	-	-

TABLE 6.

MEASUREMENT OF IMPLANT PROTRUSION INTO THE SINUS AT DIFFERENT TIME INTERVALS USING OPG & RVG-ANOVA AND POST HOC TEST

	OPG		RVG	
	N	MEAN±SD	N	MEAN±SD
BASELINE	10	2.50±1.27	10	2.40±1.65
3 MONTHS	8	2.13±1.13	8	1.75±1.04
6 MONTHS	7	2.29±1.11	7	1.86±1.07
P-VALUE	0.799ǂ		0.544ǂ	

ǂ P>0.05 – DENOTES NOT SIGNIFICANT

TABLE 7.

COMPARISON OF IMPLANT PROTRUSION INTO THE SINUS AT DIFFERENT TIME INTERVALS USING OPG & RVG-PAIRED t TEST

	OPG			RVG		
	N	MEAN±SD	P VALUE	N	MEAN±SD	P VALUE
BL	10	2.50±1.27	0.784ǂ	10	2.40±1.65	0.565ǂ
3M	8	2.13±1.126		8	1.75±1.035	
BL	10	2.50±1.27	0.929ǂ	10	2.40±1.509	0.685ǂ
6M	7	2.29±1.113		7	1.86±1.069	
3M	8	2.13±1.126	0.786ǂ	8	1.75±1.035	0.847ǂ
6M	7	2.29±1.113		7	1.86±1.069	

1. **P-VALUE ** -SIGNIFICANT AT 1 % LEVEL**
2. **P-VALUE >0.05 ǂ - DENOTES NOT SIGNIFICANT**

TABLE 8.

MEASUREMENT OF CRESTAL BONE HEIGHT IN GROUP I, GROUP II USING RVG-ANOVA AND POST HOC TEST

	GROUP I			GROUP II		
		MESIAL	DISTAL		MESIAL	DISTAL
	N	MEAN±SD	MEAN±SD	N	MEAN±SD	MEAN±SD
BL	10	2.10±1.10	2.50±1.43	10	1.80±0.92	1.30±1.16
3M	8	3.38±0.74	3.25±0.89	8	1.00±1.20	1.00±1.20
6M	7	4.00±0.63	4.00±1.10	7	0.57±1.51	0.43±1.81
P VALUE		0.001**	0.084ǂ		0.119ǂ	0.450ǂ

1. **P VALUE ** DENOTES SIGNIFICANT AT 1% LEVEL**
2. **P VALUE ǂ DENOTES NOT SIGNIFICANT**

NOTE: GROUP I: IMPLANT COLLAR TO FIRST CRESTAL BONE CONTACT

GROUP II: FIRST IMPLANT THREAD TO CREST

TABLE 9.

MEASUREMENT OF CRESTAL BONE HEIGHT IN GROUP III USING OPG-ANOVA AND POST HOC TEST

	GROUP III		
		MESIAL	DISTAL
	N	MEAN±SD	MEAN±SD
Baseline	10	7.20±2.78	7.70±4.08
3Months	8	7.13±2.10	9.00±3.46
6Months	7	8.14±2.27	10.14±4.06
P VALUE		0.450ǂ	0.672ǂ

P VALUE ǂ DENOTES NOT SIGNIFICANT

NOTE: GROUP III –ADJACENT TOOTH CEJ TO ALVEOLAR CREST

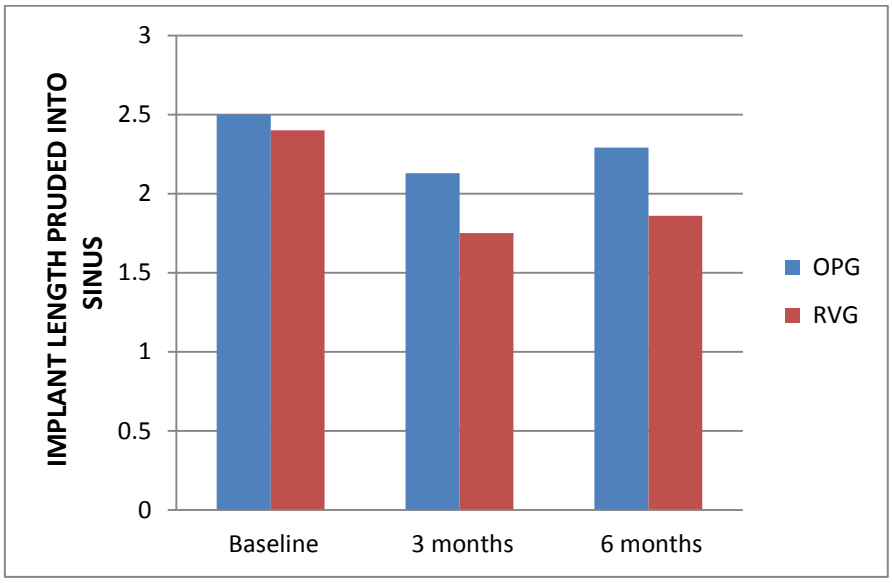
TABLE 10.

SURVIVAL OF IMPLANT AT 3MONTHS AND 6 MONTHS

CASE NO#	3 MONTH SURVIVAL	6 MONTHS SURVIVAL
No.1	yes	Yes
No.2	yes	Yes
No.3	yes	Yes
No.4	Yes	Yes
No.5	Failure	Failure
No.6	Yes	Yes
No.7	yes	Yes
No.8	yes	Yes
No.9	Failure	Failure
No.10	yes	No Review

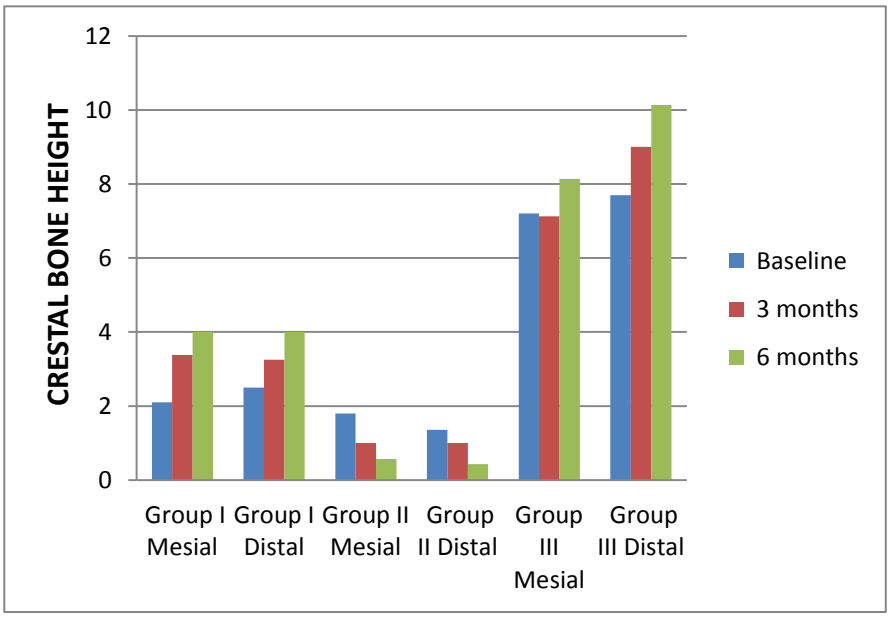
Graph 1.

Measurement of implant length protruded into sinus using OPG & RVG at different time intervals



Graph 2.

Measurement of crestal bone height in Group I and Group II using RVG and Group III using OPG



DISCUSSION

Rehabilitation of the edentulous posterior maxilla with dental implants can be difficult because of insufficient bone volume caused by pneumatization of the maxillary sinus and the degree of resorption of alveolar ridge due to prolonged edentulism and biological aging **(Scarano Antonio 2006)[88].**

The most widely used approach for sinus floor elevation is the classical lateral window technique introduced by **Tatum (1976)[104].** This technique had potential complications include tearing of the membrane, bleeding, infection, and sinus obstruction. This technique requires considerable surgical skill and time and also often giving rise to unpleasant sequelae such as oedema and discomfort.

A less invasive alternative was introduced by **Summer (1994)[99]** to obtain a smaller, localized elevation of the sinus floor. They involve a crestal approach, common to standard implant surgery, with little or no contact between the surgical instruments and the schneiderian membrane, which reduces the risk of surgical complications.

The inclusion criteria used in this study was patient with crestal bone height greater than 5mm below sinus floor. According to the standard protocol, the osteotome technique can be used when the ridge height is more than 6mm where implants are placed simultaneously with elevation of sinus floor (**Wallace 2003 Ann periodontal)[114].** Because this minimal residual bone

height remains to afford primary stability for the simultaneously inserted implant **(Fugazzotto 2002)[38].**

Among the exclusion criteria considered smoking and uncontrolled diabetes are two known risk factors that impact implant survival. The literature suggested the smoking markedly increase the risk of implant failure. Hence this study excluded the above risk factors among the other exclusion criteria **(Lindhe 2008)[59].**

Dental implant placement associated with augmentation of the sinus floor in a severely atrophied maxilla can be performed in one or two surgical stages depending on the height of the residual alveolar bone. In a one-stage procedure, a minimum base height of 4 to 5mm is recommended for adequate implant stabilization and parallelism. A two-stage approach is performed when there is insufficient residual bone. This allows healing of the graft material for future implant sites (**Smiler DG1992**)**[92].**

Sinus elevation technique has shown a reasonable degree of predictability in implant survival .Success criteria for endosteal implants have been proposed previously by several authors. The report by **Albrektsson et al (1986)[2]** is widely used today. However, it does not consider the amount of crestal bone lost during the first year. The success criteria most commonly reported in clinical reports is the survival rate, meaning whether the implant is still physically in the mouth or has been removed

(Ten Bruggenkate C 1990)[105]. Hence the evaluation of survival of implant has a impact on overall predictability of long term implant success.

The transcrestal approach of osteotome to elevate sinus membrane well beyond 4 to 5mm is well documented in the literature **(Reiser 2001)[79].** The length of implant that can protrude into sinus is based on the elastic property of moist sinus soft tissue. This can evaluate the changes in the height of maxillary sinus floor for each implant **(Borges L.Fabio 2011)[8].**

The marginal bone around the implant crestal region is usually a significant indicator of implant health. One of the most important criteria for evaluating implant success is determining crestal bone levels surrounding an implant, Initial breakdown of implant-tissue interface begins at the crestal region in a successfully osseointegrated endosseous dental implant. Stress concentration is found to be concentrated more on crestal region when compare to implant apex. Crestal bone loss can lead to increased bacterial accumulation resulting to secondary periimplantitis which can further result in loss of bone support leading to occlusal overload and gain crestal bone loss **(Steflik J Dent Res 1982)[97]**. This vicious cycle, has been associated with implant failure. The most common method in the literature to assess bone loss after healing is by radiographic evaluation. Conventional radiographs only monitor the mesial or distal aspect of bone loss around the implant body **(Carl E. Misch 2008)[13].**

Loading protocols for the dental implant treatment of edentulous jaws have been widely discussed in the dental literature. Initial implant stability, implant surface characteristics, bone quality, bone healing, interim prosthesis design, and occlusion pattern during the healing phase have been identified as influential factors in successfully achieving osseointegration with modified loading protocols **(Chiapasco M 2004)[17].**

Conventional loading protocol describes implant-supported rehabilitations in edentulous maxillae that have been in occlusal function after a healing period of 3 to 6 months. A successfully osseointegrated oral implant is anchored directly to bone; however, in the presence of movement, a soft tissue interface may encapsulate the implant, causing its failure. To minimize the risk of soft tissue encapsulation, it has been recommended that implants be kept load-free during the healing period 3 to 4 months in mandibles and 6 to 8 months in maxilla (**Brånemark P-I 1969)[10].**

Postoperative complications were recorded in this study. There was a subjective sign of postoperative pain and swelling reported in 2 patients. There was no Benign paroxysmal positional vertigo, sinus perforation, sinusitis, discharge from nose or oroantral fistula reported in this study. None of the patients exhibited sinus pathology during the 6 month follow-up period. This was probably the result of meticulous surgical protocol, patient selection and the minimal invasiveness of indirect osteotome technique. In consistent with this study, **Jung et al (2007)[52]** reported no clinical signs of sinusitis were

found in 9 patients with 23 implants inserted into maxillary sinus. **Michele Di Girolama (2005)[65]** has reported paroxysmal positional vertigo in four patients out of 146 patients who have undergone bone added osteotome sinus floor elevation.

In this study all the patients reviewed for 6 months except for one patient with 3 months review. Conventional loading protocol was followed where seven patients are successfully loaded after 6 months period with cement retained metal-ceramic restoration and one patient with screw retained due to lack of interocclusal clearance. Complementarily, **Nicola Marco et al (2008)[73]** has also reported loading time ranged from 5 to 74 months using this procedure. Likewise**, Cavicchia Fabrizio (2001)[14]** also loaded for a period between 6 and 90 months (mean 35 months) using coronal approach with simultaneous implant placement. **ZembićA, et al (2010)[120]** has demonstrated that immediate loading was associated with a lower implant survival rate.

The present study assess the survival of 10 dental implants in 8 patients which is placed simultaneously using indirect osteotome technique without bone grafts and followed for a period of 6 months. In this study Implant survival is assessed over a period of 6 months using the survival criteria proposed by **Buser *et al* and Cochran *et al* (1997)[12]** were assessed clinically and radiographically: (i) absence of clinically detectable implant mobility, (ii) absence of pain or any subjective sensation, (iii) absence of recurrent

periimplant infection, (iv) absence of continuous radiolucency around the implant. Radiographic evaluation done using Panaromic radiographs and digital periapical radiographs were taken at the time of implant placement, 3 months and 6 months. They were analyzed by the same investigator. Results showed that 7 implant survived out of 9 implants when followed over a period of six months among which one patient has no 6 months postoperative. Early implant failure was recorded in two patients due to loss of osseointegration.

In agreement with this study **Rosen et al (1999)**[87] reported, the survival rate of 96% when residual bone height was 5 mm or more but declined to 85.7% when residual bone height was 4mm or less. In a recent study **Ferrigno et al (2006)**[34]**,** survival and success rates of 588 implants placed in 323 consecutive patients with a residual bone height ranging from 6 to 9mm were evaluated. After a mean observation period of 5 years, the survival and success rates were 94.8% and 90.8% respectively

Likewise, **Diss et al (2008)**[27] placed 35 implants using drills and osteotome without bone graft with the residual bone height of 6.5±1.7 mm achieved a 97.1% survival rate. **Fermegard et al (2008)**[33] placed 53 dental implants using indirect osteotome technique without bone graft with a residual bone height of 6.3±0.3mm showed 96% survival rate

In this study the length of implant protruded into sinus was assessed radiographically using RVG and OPG in 3 months and 6 months period.OPG showed mean length of 2.13±1.13 mm protruded into sinus. Whereas RVG

showed mean length of 1.74±1.04mm. . There was no significant change in the length of implant protruded into the sinus over a period of 6 months, demonstrated that there no changes in maxillary sinus floor level (P>0.05).

Previous studies reported by **Patrick Schmidlin (2008)[75] s**howed radiographically osteotome sinus elevation of 3.6±1.6 mm measured as the distance between the implant apex and initial sinus floor, were 2.6±1.8mm mesially and 2.8±1.7 mm distally**. Cavicchia Fabrizio et al** (**2001)[15]** reported the displacement of sinus varied from 1 to 6mm (mean 2.9mm) evaluated in a periapical radiograph.

In this study Crestal bone height was evaluated with a series of digital periapical radiographs and OPG at baseline, 3 and 6 months. Mean Mesial crestal bone height in group I which is the measurement from implant collar to first crestal contact showed 2.10±1.10 at baseline, 3.38±0.74 at 3 months and 4.00±0.63 at 6 months which was statistically significant (P<0.001). Mean Distal crestal bone height did not show any significant difference at 3 months and 6 months. Mean Mesial and distal crestal bone height in Group II and Group III was not statistically significant (P>0.05).

The preceding studies by **Miguel Penarrocha (2004)[66]** evaluated the periimplant bone loss using conventional periapical, Digital periapical and extraoral Panaromic radiographs at the time of prosthetic loading and after 1 year. Average periimplant bone loss was 1.36 mm as measured on OPG, 0.76 mm on conventional radiographs and 0.95 mm as measured on digital

periapical radiographs **Young-Kyu Shin et al (2006)**[118] assessed radiographically marginal bone level around implant with different neck surface. The group with rough surfaced microthreaded implant neck showed least amount of bone loss(mean 0.18±0.16 mm) and the group with machined neck showed greatest amount of bone loss (mean 1.32±0.27 mm) after 1 year of functional loading

Hence this technique of indirect sinus lift with simultaneous implant placement proved to be less invasive with no postoperative morbidity and also demonstrated predictable degree of implant survival and minimal crestal bone loss without use of bone graft.

SUMMARY AND CONCLUSION

This study included ten systemically healthy patients (5 males and 3 females) within the age group of 25-55 years requiring maxillary sinus augmentation for implant placement were selected. Indirect sinus lift procedure using osteotome with simultaneous implant placement was done and followed for 6 months period.

Survival of implant and postoperative complication were recorded. The parameters assessed being length of implant protruded into sinus and crestal bone height at base line, 3rd month and 6th month using OPG and RVG.

Clinically, no complications were observed during or after the surgical procedure. There was no significant change in the length of implant protruded into the sinus over a period of 6 months, demonstrated that there was no change in sinus floor level ($P>0.05$).

Mesial crestal bone height in group I which is the measurement from implant collar to first crestal contact. Showed 2.10±1.10 at baseline, 3.38±0.74 at 3 months and 4.00±0.63 at 6 months which was statistically significant ($P<0.001$).Two early implant failures were reported and seven implants out of ten were successfully restored in function.

Thus, it is appropriate to conclude that, indirect sinus lift with simultaneous implant placement has shown predictable degree of implant survival and minimal crestal bone loss without use of bone graft. This method has obvious advantages, paving way for maximal augmentation of the sinus for successful implant placement in future.

However, further controlled clinical trials with large sample size, advanced radiographic and histomorphometric analysis should be executed to evaluate the effectiveness and safety of this technique compared to other sinus augmentation procedures.

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